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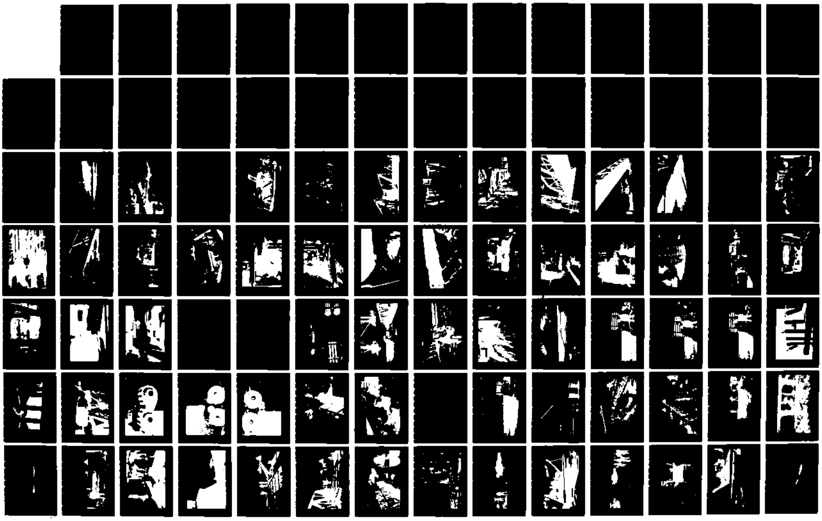

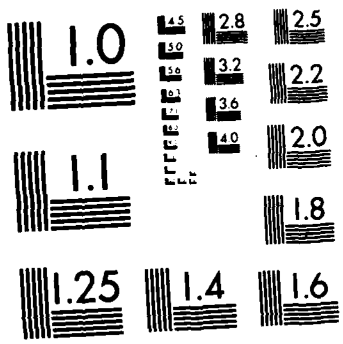

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Bethesda, Maryland 20084

DEPARTMENT OF THE NAVY DTNSRDC

DTNSRDC/SDD-83/5

ROLL-ON/ROLL-OFF (RO/RO) MERCHANT VESSEL OFFLOADING FACILITY TEST WITH THE CALM WATER RAMP (CWR) (COTS CNO PROJECT 299, DT-IM-2)

ROLL-ON/ROLL-OFF (RO/RO) MERCHANT VESSEL OFFLOADING FACILITY TESTS WITH THE CALM WATER RAMP (CWR) (COTS CNO PROJECT 299, DT-IM-2)

by

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SYSTEMS DEVELOPMENT DEPARTMENT

RESEARCH AND DEVELOPMENT REPORT

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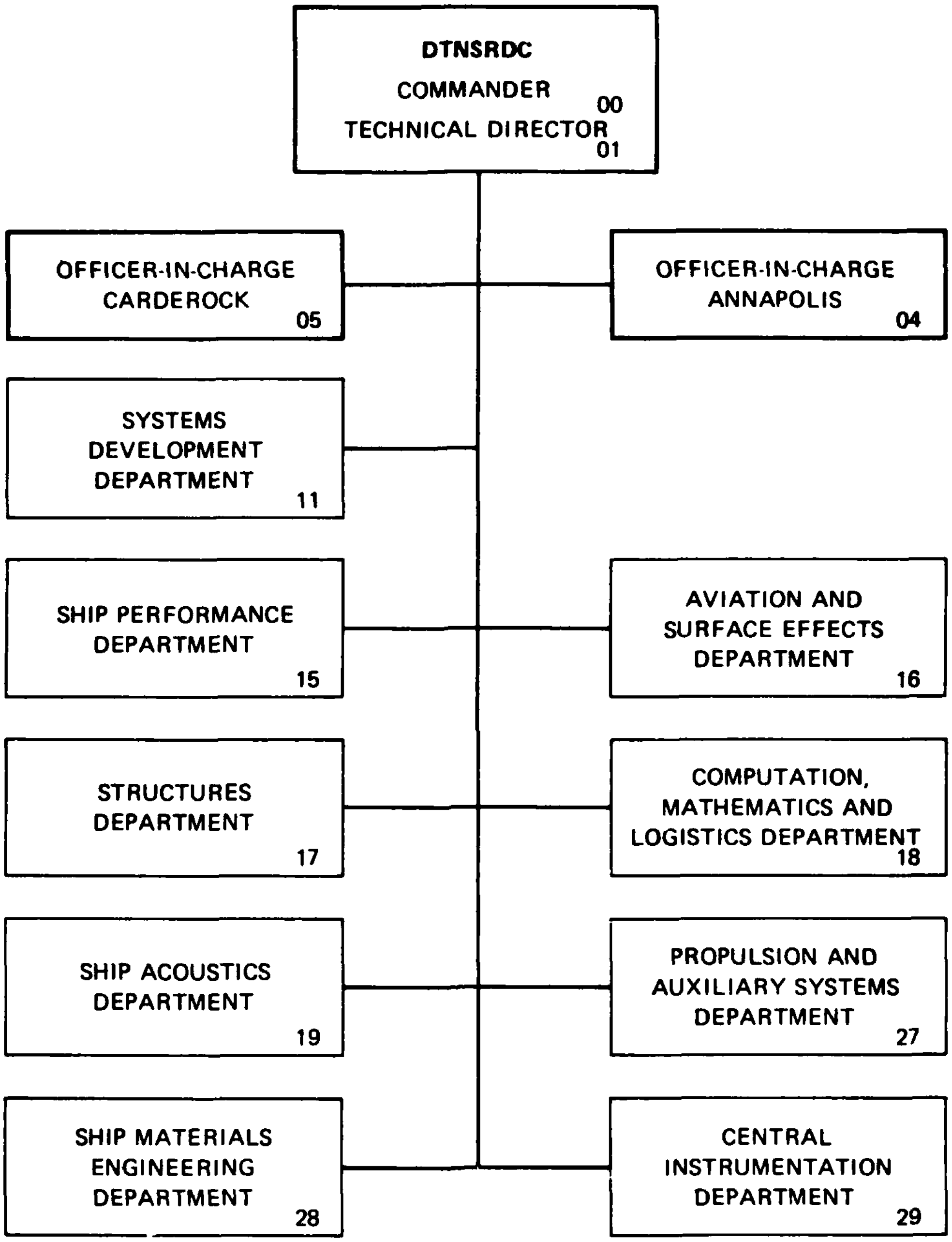

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The United States has long included merchant ships in plans to support Navy-Marine Corps Amphibious Assault Follow-On Echelon (AFOE) and Army Logistics Over-the-Shore (LOTS) operations. The shift toward port-dependent cargo ships has given rise to the investigation of other methods/facilities to offload cargo without getting into development of complex harbor facilities similar to those used commercially. The tests with the

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calm water ramp (CWR) demonstrate, in part, the viability of using the ramp to offload nonself-sustaining roll-on/roll-off (RO/RO) ships in an offshore setting. Due to the unavailability of a nonself-sustaining RO/RO ship, all tests were designed to correspond and reproduce actual operating parameters. The ramp was raised through the extremes of its operating range and several representative military vehicles were driven up an inclined section of the CWR. The Causeway Platform Facility (CPF) was configured for ramp operations and moored alongside the merchant ship SS AMERICAN TROJAN where simulated vehicle offloadings from Causeway Ferries and Landing Crafts, Utility (LCUs) were conducted. Based on these tests, the CWR and the CPF have demonstrated that can operate effectively to satisfy all of their design requirements.

TABLE OF CONTENTS

LIST OF FIGURES

Page

Page

ABSTRACT

The United States has long included merchant ships in plans to support Navy-Marine Corps Amphibious Assault Follow-On Echelon (AFOE) and Army Logistics Over-the-Shore (LOTS) operations. The shift toward port dependent cargo ships has given rise to the investigation of other methods/facilities to offload cargo without getting into development of complex harbor facilities similar to those used commercially. The tests with the calm water ramp (CWR) demonstrate, in part, the viability of using the ramp to offload nonself-sustaining roll-on/roll-off (RO/RO) ships in an offshore setting. Due to the unavailability of a nonself-sustaining RO/RO ship, all tests were designed to correspond and reproduce actual operating parameters. The ramp was raised through the extremes of its operating range and several representative military vehicles were driven up an inclined section of the CWR. The Causeway Platform Facility (CPF) was configured for ramp operations and moored alongside the merchant ship SS AMERICAN TROJAN where simulated vehicle offloadings from Causeway Ferries and Landing Crafts, Utility (LCUs) were conducted. Based on these tests, the CWR and the CPF have demonstrated that they can operate effectively to satisfy all of their design requirements.

ADMINISTRATIVE INFORMATION

These developmental tests are an integral part of the Naval Facilities Engineering Command (NAVFAC) program to develop methods for offloading military cargo from roll-on/roll-off (RO/RO) merchant ships. The NAVFAC program is CNO Project No. 299, Container Offloading and Transfer System (COTS). The program developmental test designation is DT-IM-2. The program manager for the subject test is NAVFAC 032B. Technical program development and test direction were provided by the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), Mobile Support Systems Office, Code 1190, Task Area Y0816.002 and Work Unit 1190-155, with the support of the Naval Civil Engineering Laboratory (NCEL), Amphibious and Harbor Division, Code L55, and Puget Sound Naval Shipyard (PSNS), Design Code 280.3. The tests were accomplished by the Amphibious Construction Battalion Two (PHIBCB TWO), Little Creek, Virginia with support from the Marine Corps, U.S. Army, and the National Guard.

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Navy

Amphibious Construction Battalion Two, Little Creek, Virginia

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Fourth Marine Division, New Orleans, Louisiana

U.S. Army

U.S. Army Transportation Center, Fort Eustis, Virginia

National Guard

Virginia National Guard, Richmond, Virginia

Other

Naval Civil Engineering Laboratory, Port Hueneme, California;
Military Sealift Command, Washington, D.C.;
Puget Sound Naval Shipyard, Bremerton, Washington; and
J. J. Henry, Inc., Portsmouth, Virginia

1.0 INTRODUCTION

1.1 BACKGROUND

Department of Defense (DOD) level planning for the logistics support necessary to sustain major contingency operations, including Amphibious Assault Operation Landings and Logistics Over-the-Shore (LOTS) evolutions, relies extensively on the utilization of U.S. Flag commercial shipping assets. The recent trends in commercial shipping have been increasing toward containerships, roll-on/roll-off (RO/RO) ships, and barge ships (e.g., LASH, SEABEE).

Amphibious assault operations or LOTS contingency operations are usually conducted over undeveloped beaches where port facilities are not available. Therefore, DOD is faced with the problem of offloading its military cargo from the various classes of transmodal ships and moving the cargo inland without the aid of normal port facilities.

A significant amount of the Assault Follow-On Echelon (AFOE) equipment consists of vehicles or equipment ultimately intended to be carried on a vehicle. For this reason, RO/RO ships are ideally suited to AFOE support. Loading and unloading vehicles on the RO/RO ships is currently carried out, however, only from/to a pier facility not generally available at an assault beach. A requirement exists to offload vehicles from a RO/RO ship to an undeveloped assault beach in order to make optimum use of U.S. Flag assets in AFOE support. Reference 1* summarizes the engineering studies and various investigations which were completed to satisfy this requirement.

These studies and investigations recommend that offloading operations utilize an intermediate platform from which lighters would transfer the cargo to the beach. Model experiments were conducted to evaluate the performance of several floating platform configurations made from connecting individual causeway sections together to form a sufficiently large platform to support a vehicle offloading ramp and allow drive-off of vehicles from the ship. These model experiments[2] concluded that a platform

*A complete listing of references is given on page 15.

configuration of six causeway sections connected in two rows by three abreast (2 x 3) was superior to all the other platforms examined. This 2 x 3 platform has been named the Causeway Platform Facility (CPF). During the summer of 1982, various CPF assembly tests were conducted to develop and demonstrate CPF assembly techniques and evaluate CPF motions under various sea state conditions (Sea State 1-3). These tests are documented in Reference 3.

There are two basic classifications of RO/RO ships, self-sustaining and nonself-sustaining. Self-sustaining RO/ROs are configured to transport and deploy their own vehicle offloading ramps. During September 1982, tests were conducted with a self-sustaining RO/RO ship, the MS CYGNUS. These test are documented in Reference 4. Nonself-sustaining (NSS) RO/ROs do not carry their own ramps and therefore these ships must depend upon ports with extensive pier-side ramp facilities for their normal trade operations. For military operations with NSS RO/ROs, a special Calm Water Ramp (CWR) and adjustable platform fenders are installed on the CPF to enable offshore discharge of vehicles. The original plans for conducting the developmental test (DT-IM-2) envisioned the use of a PONCE/LURLINE or GREAT LAND Class NSS RO/RO. Unfortunately, no ship owners were willing to remove their vessels from trade operations for the desired one week test duration. The test plans were therefore changed to conduct a series of tests which would closely simulate NSS RO/RO operations. This report documents those tests.

1.2 SCOPE

The tests consisted of (1) raising the CWR through its extreme operating inclinations and movement of vehicles on an inclined section of the ramp (this portion of the test is covered in Section 2) and (2) mooring the CPF with installed CWR and fenders alongside the SS AMERICAN TROJAN and performing Causeway Ferry and Landing Craft, Utility (LCU) marriages to the CPF (see Section 3).

Details of the CPF, Causeway Ferries, LCUs and supporting craft are presented in References 4 and 5 and have not been included herein.

1.3 MERCHANT RO/RO SHIPS

The operating NSS U.S. Flag RO/RO vessels are either of the PONCE/LURLINE class or GREAT LAND class. The PONCE/LURLINE class ships carry trailers primarily, with special tractors and ramps provided by the ports serviced. Loading and unloading is done through three side ports located on the starboard side; no stern passage is provided on this class. The GREAT LAND class ships are stretched versions of the PONCE class, with approximately 91 ft added to the midbody for an overall length of 790 ft. A mezzanine deck forward of the superstructure provides extra cargo capacity. Several variations are found in the loading scheme, depending on the trade route that the ship services. Three starboard ports were built into all ships at approximately the same locations as the PONCE class. On some ships, two ports are added in the transom at the second deck. In all cases, ships' winches are used to hoist shore-based ramps to the ship. Number, arrangement, and capacity of the winches is essentially unchanged from the PONCE class design. Table 1 shows the ship's principle characteristics and includes the port sizes.

In the absence of an available NSS RO/RO ship, the merchant breakbulk ship SS AMERICAN TROJAN (Figure 1) was utilized to demonstrate alongside mooring of the CPF and subsequent marriage operations with Causeway Ferries and LCUs. The SS AMERICAN TROJAN, with the CPF at midships, is shown in Figure 2.

1.4 TEST ARTICLES

The CPF is made up of six 21-ft by 90-ft causeway sections connected together to form a floating platform about 65 ft wide by 180 ft long. As shown in Figure 2, the CPF includes adjustable fenders, a ramp landing mat (steel plate and wood dunnage), a CWR, and miscellaneous support equipment. The CWR resembles a steel trussed bridge and consists of three 40-ft long sections connected together to form a 120-ft long ramp. Figure 3 provides CWR dimensions and individual ramp section weights. The CWR can be assembled in an 80-ft configuration for pier-side use. However, when installed on the CPF, the CWR must be in the 120-ft length to ensure that the ramp inclination is no more than 15 deg after being installed at the

TABLE 1 - CHARACTERISTICS OF NSS RO/RO SHIPS

	PONCE/LURLINE Class	GREAT LAND Class
Ships Available	5	5
Ships Names	PONCE BAYAMON PUERTO RICO LURLINE MATSONIA	GREAT LAND FORTALEZA CAGUAS ATLANTIC BEAR WESTWARD VENTURE
Length (ft)	700	790
Breadth (ft)	105	105
Draft (ft)	28	28
Speed (knots	24	24
Maximum Displacement (long tons)	25,350	31,762
Clear Deck Area (ft^2)	150,000	211,100
Deck Height (ft)		
Main	15 in super structure tunnels	15 under spar deck
2nd	15	15
3rd	15	15
4th	7 or 15	13'7" to 15
5th	N/A	N/A
Stern Ports(s) (hxw) (ft)	N/A	16x16 (2)
Side Ports(s) (hxw)	Forward 15'3"x24' Midship 15'3"x24' (2 ships) 11x24' (3 ships) Aft 15'3'x21'	Forward 15'3"x24' Midship 15'3"x24' Aft 15'3"x21'

NSS RO/RO's offloading port. The maximum load capacity of the CWR is 134,000 lb. See Reference 5 for further details of the CPF, CWR, fenders, etc.

1.5 CALM WATER RAMP LOAD VERIFICATION TEST

The load/weight testing of the ramp was done by the fabrication contractor. A 90-ton capacity commercial crane (Figure 4) was used for the dynamic test load, and two large water tanks (Figure 5) were used for the static load test. The dynamic load test was conducted on 3 August 1982 and consisted of 140,000-lb crane traversing the length of the CWR a total of 10 times. The static load test was conducted on 4 August 1982 and consisted of filling two large water tanks with water for a 238,900-lb test load which was maintained for a period of 30 min. Both of these tests were performed with the CWR assembled in the 80- and 120-ft configurations.

During the load/weight tests, strain gauge readings were taken from instruments placed at strategic spots on the CWR. These readings indicated a stress due to loading only of 11.3 ksi which occurred during the static load testing. Since the yield strength is 36 ksi, the low measured stress indicates the structural adequacy of the ramp.

2.0 RAMP INCLINE TESTS

2.1 INTRODUCTION

The ramp incline test consisted of a series of subtests designed to simulate every aspect of offloading a nonself-sustaining RO/RO ship with the CWR. These subtests consisted of the following:

- Ramp inclination to 15 deg
- Ramp shoe friction test
- Ramp vehicle/traction test

The results of these tests are presented in detail in the following sections.

2.2 RAMP INCLINATION TO 15 DEGREES

The purpose of this test was to determine the maximum force required to lift the ship end of the CWR and to verify the proper operation of the

ramp shoes on the CPF. Figure 6 shows a Floating Crane (YD) lifting sling attached to the "Z" bracket support shackles. In order to accomplish this lift, the "Z" brackets had to be removed and were placed on the ramp in order to maintain the proper ramp weight distribution (see Figure 7). The YD lifted the CWR to a 15-deg angle as shown in Figures 8, 9, and 10. The maximum force required to lift the CWR to the 15-deg orientation was 85,000 lb. The ramp shoes rotated about their pinned connections satisfactorily, and proper contact with the wood dunnage was maintained as shown in Figure 11.

These tests verified that NSS RO/ROs can hoist the CWR to a 15-deg orientation by using the ship's ramp handling winches since each winch has a rated load capacity of 25 long tons. The tests also confirmed that the ramp lifting and dragging procedures described in Reference 5 will work.

2.3 RAMP SHOE FRICTION TEST

The purpose of the ramp shoe friction test was to determine the actual force required for a warping tug to pull the CWR away from the ship. Figure 12 shows this arrangement at a NSS RO/RO. The test operation required a warping tug winch in a two part purchase to slide the CWR as shown in Figure 13.

The actual force required to overcome static friction was approximately twice the 10,250 lb shown by the gauge maximum indicator in Figure 14, or 20,500 lb. The force required to move the ramp once the static force was overcome was approximately twice the 5,500 lb shown in Figure 14, or 11,000 lb. These figures indicate a coefficient of static friction of approximately 0.29 and kinetic friction of approximately 0.16. The second of these figures compares somewhat closely with the predicted handbook value of 0.13 for the movement of polyethylene on wood (lightly sanded). The rough finish of the wood dunnage probably contributed to the higher coefficient of kinetic friction. The high value of static friction has been determined to be the result of two factors. The first factor was the rough cut and varying thickness of soft lumber which gave the dunnage a rough surface texture susceptible to compression. The second factor was that the polyethylene foot pads had 90-deg edges, which suggests that the

high value of static friction had more to do with the ramp feet getting over a self induced ridge in the dunnage than with overcoming true static friction. For this reason it is recommended that the edges of polyethylene foot pads be beveled at a 45-deg angle to facilitate movement of the ramp on wood dunnage.

The test demonstrated that a warping tug's winch could easily pull the CWR away from the ship. The test also confirmed the adequacy of the CWR removal procedures described in Reference 5.

2.4 RAMP VEHICLE/TRACTION TEST

The purpose of this test was to evaluate vehicle traction characteristics on the CWR. The vehicle/traction test was conducted utilizing the platform section of the CWR. One end of the ramp was elevated sufficiently to incline the ramp to 15 deg (see Figure 15). With this orientation of the CWR section, three representative vehicles, two tracked and one wheeled, were driven on the section to verify adequate vehicular movement and traction.

The first vehicle to negotiate the inclined CWR section was an LVTP7 (see Figures 16 and 17). The clearance on each side of the vehicle is shown in Figures 18 and 19. The useable width of the ramp is 14 ft and the width of the LVTP7 is 10 ft 9 in. The only problem encountered was that the 3/4 in. diameter traction studs on the ramp tended to gouge the rubber traction pads on the LVTP7 (see Figures 20 and 21). Since only small amounts of rubber were gouged from the pads, this problem was not considered to be significant.

The second vehicle to traverse the inclined CWR section was the M48 Tank as shown in Figure 22. The side clearances are shown in Figures 23 and 24. The width of the M48 Tank is 11 ft 11 1/2 in. which allows 1 ft of clearance on each side. There were no problems encountered with gouging of the rubber tread pads on the M48 Tank (see Figure 25). Because of the tight clearance and relative short length of the ramp test section, the tank driver requested one of his men to guide him up the ramp. During actual offloading operations it will not be possible to have a guide in front of a tank for safety reasons. This is not anticipated to be a

problem but has been highlighted here to ensure this area be further investigated during actual operational testing with tanks.

The third and final vehicle to negotiate the inclined CWR section was the M35 2 1/2-ton cargo truck as shown in Figures 26 through 28. The width of the M35 is 8 ft 0 in. which allows 3 ft of clearance on each side (see Figure 29 and 30). There were no problems encountered with the M35 on the ramp.

All of the test vehicles demonstrated excellent traction on the CWR deck surface. The CWR traction studs in combination with a painted nonskid surface provided an excellent roadway surface for the vehicles.

3.0 SS AMERICAN TROJAN TEST

3.1 INTRODUCTION

The tests with the SS AMERICAN TROJAN were conducted on 17 and 18 November 1982 with the ship at anchor in the Chesapeake Bay. See Figure 31 for details of the test setting.

The basic operating plan for the two days of testing was to moor the CPF to the starboard midship location and perform all necessary tests from this location (see Figure 32). On test day 2 the platform was positioned against the port side of the ship for approximately one-half hour to observe CPF motions when on the windward side of the ship.

3.2 TEST INSTRUMENTATION PLAN

In order to fully evaluate the simulation tests with the SS AMERICAN TROJAN, environmental conditions and the responses of the CPF were measured. A fully equipped portable instrumentation trailer was used in determining the following:

a. Wave height (buoy)
b. Current speed (current meter)
c. Current direction (current meter)
d. Wind speed (wind meter)
e. Wind direction (wind meter)
f. Platform yaw angle/heading (yaw gyro or gyro compass)
g. Pitch-primary section (gyroscope)

h. Pitch-side section (gyroscope)

i. Pitch-forward section (gyroscope)

j. Roll-primary section (gyroscope)

k. Roll-side section (gyroscope)

l. Roll-forward section (gyroscope)

m. Color video movies (one camera - hand held)

n. Latitude (SATNAV)

o. Longitude (SATNAV)

This data was reduced on a microprocessor during the tests to provide the following:

a. Mean values

b. RMS values

c. Maximum values

d. Minimum values

e. Significant amplitudes

f. Number of double amplitudes

g. Histograms

h. Time histories (selected measurements)

i. Spectral densities (selected measurements)

Selected results for each test day are presented within Section 3. The detailed instrumentation analysis is covered by Reference 6.

3.3 TEST OBJECTIVES

The overall objective of the tests with the SS AMERICAN TROJAN was to verify that the CPF, in its CWR configuration, can support mooring and lighterage operations from a nonself-sustaining RO/RO ship while in stream. Other test objectives were evaluated and reported[4] during earlier tests with a self-sustaining RO/RO ship (the MS CYGNUS). This permitted the test objectives for this series of tests to be more specifically oriented toward other areas of concern. Specifically these are:

1. To determine if the CPF can be moored adequately at side port locations.

2. To determine the minimum number of resources (equipment,

personnel, warping tugs/tender boats, etc.) required to moor the CPF.

3. To determine if a Causeway Ferry can be properly secured to the causeway platform while the platform is moored at a side port location.
4. To determine the compatibility of the causeway platform with U.S. Army and Navy LCUs.
5. To assess all of the above objectives under a dynamic test environment to better define sea state and relative motion limitations.

3.4 TEST OBJECTIVE 1 - MOORING

Test objective 1 is "to determine if the CPF can be moored adequately at side port locations."

The CPF, which had a B section installed to facilitate LCU marriages, was moved to the ship from the PHIBCB TWC Base by two warping tugs. The tugs were tied off to the B section as illustrated in Figure 32. On 17 November, the seas were calm with no appreciable wind. The warping tugs positioned the CPF alongside the ship with no difficulty. The approach speed was approximately 1 knot. The fender absorbed the impact with the ship without incident. The CPF was moored to the ship through the use of five mooring lines provided by the ship. The sequence of passing the mooring lines and the actual time each line was secured on the CPF is shown in Figure 32. The total mooring time was 35 min. Figures 33 through 37 show the mooring operation. Note that only four personnel were required to pull the longest floating polypropylene mooring line to the appropriate bitt (Figure 35).

The approach to the ship on 18 November was much faster than the previous day and at an oblique angle (Figure 38). It was estimated that the CPF hit the ship's side at approximately 2 knots. This impact damaged several of the fender support pipes on one fender assembly. Figures 38 through 42 show the CPF approaching the ship, the actual impact, and the resulting damage. The approach angle to the ship was necessary to account for current and wind. The damage to the fender support pipes could have

been eliminated had the pipes been shorter thereby not extending beyond the end of the fender. The damage was minimal and didn't affect further testing. The CPF was then moored to the ship in approximately the same manner as the day before. The total mooring time was 22 min (13 min faster than the first day).

The fender assemblies worked well in keeping the CPF structure clear of the ship and also in accommodating relative motion between the CPF and the ship. Figures 43 through 46 illustrate the arrangement and operation of the fenders. Some movement of the entire fender support frames on the CPF was noted on 18 November when the wind increased to about 10 knots with a significant wave height of approximately 2 ft. The movement was in "tolerances" in the bolting pattern between the foundation and ramp structure. Upon inspection, it was determined that lock washers were missing from the bolts. The bolts were tightened which reduced the movement (see Figures 47 and 48).

The forces incurred by the mooring lines and the fender system were determined by attaching a dynamometer to a warping tug's line and pulling the CPF with attached four section Causeway Ferry and an LCU (see Figure 49). A force of 10,000 lb was required to slack all of the mooring lines. With this force established, actual mooring line forces can be calculated. The mooring line forces are shown in Figure 49.

The attachment method for the inward mooring lines varied as shown in Figures 50 and 51. For these bitt locations the lines should be double wrapped as shown in Figure 50.

Once the CPF was moored to the ship no craft were required to maintain the CPF in position. Unmooring operations involved removing the mooring lines and backing the CPF away from the ship.

3.5 TEST OBJECTIVE 2 - RESOURCES

Test objective 2 is "to determine the minimum number of resources (equipment, personnel, warping tugs/tender boats, etc.) required to moor the CPF."

The Navy resources required for mooring the CPF consisted of essentially two crafts, one to position the CPF fore and aft, the other to

position it transversely until the ship's lines were passed and secured. Because of the number, length, and distance of the passed lines, a minimum of four line handlers is required (see Figure 35). Additionally, radio contact with the ship must be maintained, preferably with the passing of a Navy radio to the ship.

The ship's resources required for mooring the CPF consist primarily of a radio man and mooring lines of sufficient quantity, strength, and length plus their accompanying winches/capstan and line handlers.

3.6 TEST OBJECTIVE 3 - CAUSEWAY FERRY

Test Objective 3 is "to determine if a Causeway Ferry can be properly secured to the causeway platform while the platform is moored at a side port location."

The Causeway Ferry was successfully moored three times to the platform, twice on the windward side, as shown in Figures 52 through 56, and once on the leeward side, as shown in Figures 57 and 61. The effects of increased winds and current on day 2 are evident in Figures 57 through 61 as the support craft works to bring the Causeway Ferry to the CPF. A craft (warping tug or tender boat) pushing on the leeward side of a Causeway Ferry would improve marriages to the CPF. One of the two crafts attending the CPF could be repositioned for this purpose.

3.7 TEST OBJECTIVE 4 - LIGHTERAGE

Test Objective 4 is "to determine the compatibility of the causeway platform with U.S. Army and Navy LCUs."

Only one U.S. Army LCU was used during the two days of testing. On the first test day LCU marriages were made both with an alongside Causeway Ferry (see Figure 62) and without the ferry (see Figure 63) with no difficulty. On day 2 the LCU experienced difficulty maneuvering to a marriage both with and without an adjacent windward Causeway Ferry. Two tries totaling 12 min were required to complete the marriage with the adjacent Causeway Ferry (see Figures 64 through 68). When the Causeway Ferry was removed the LCU attempted six tries at marriage to the B section before giving up (see Figure 69 through 71).

The tests showed that LCU bow marriages to a B section alone are possible in Sea State 0 to 1 conditions, but virtually impossible in Sea State 2 conditions. Under the same basic sea conditions, an LCU bow marriage could be accomplished if a Causeway Ferry was attached to the windward side of the CPF. The Causeway Ferry formed a lee for the LCU and also provided a location to secure side mooring lines to the LCU.

3.8 TEST OBJECTIVE 5 - ENVIRONMENT

Test Objective 5 is "to assess all of the above (previous) objectives under a dynamic test environment to better define sea state/relative motion limitations."

The environmental conditions encountered are presented in Reference 6 and are briefly summarized as follows:

November 17, 1982 no data, calm seas

November 18, 1982

Wind:	Speed	10 knots		
	Direction	060 deg		
	Time	0750		
Current:	Speed	0.6 knots		
	Direction	135 deg		
	Time	1123		
Significant Wave Height:		1.7 ft	to	2.2 ft
	Direction	060 deg		130 deg
	Time	0750		1123

The dynamic response of the CPF was measured during the most severe sea and wind conditions encountered. This occurred at approximately 11:30 a.m. on 18 November. The maximum motions (double amplitudes) of the causeway section carrying the portable instrumentation trailer were as follows:

Pitch	1.2 deg
Roll	8.9 deg
Vertical Acceleration	0.126 g's

The maximum relative motions (double amplitude) between CPF sections were as follows:

Pitch	1.7 deg
Roll	9.4 deg
Vertical Acceleration	0.171 g's

The effects of the dynamic environment, especially during day 2, have been included in the previous sections.

4.0 CONCLUSIONS

4.1 GENERAL

Based on the simulation test conducted with the CWR and the CPF, the following concluding statement can be made:

> "The CWR and the CPF have demonstrated, in the absence of actual testing with a nonself-sustaining RO/RO ship, that they can operate effectively to satisfy all of their design requirements."

Specific conclusions for each aspect of the simulation tests are summarized in paragraphs 4.2 and 4.3.

4.2 RAMP INCLINE TESTS

a. A NSS RO/RO can hoist and drag the CWR to its offloading port by using the ship's ramp handling winches.

b. The CWR can move throughout its maximum design angle of 15 deg.

c. The warping tug winch can readily pull (force of 20,500 lb) the CWR away from the ship over material having the greatest coefficient of friction (rough cut wood dunnage).

d. The traction studs plus the nonskid covering of the ramp's surface provide excellent traction for personnel and vehicles (both wheeled and tracked, wet and dry.)

e. Larger width vehicles (over 10 ft) need to exercise extra time and caution when traversing the ramp.

4.3 SS AMERICAN TROJAN TEST

a. The CPF can be easily moored at side port locations under Sea State 2 conditions.

b. The basic resources for mooring the CPF at sideport locations are

two handling craft, one for longitudinal movement, the other for transverse positioning.

c. Causeway Ferries can be readily married to the CPF in Sea State 0-1. In Sea States 1-2 the process becomes more difficult, but it can be eased when an adjacent causeway section is present, thus creating an alignment guide for the ferry.

d. The addition of Causeway Ferries to the CPF increases the forces on the CPF mooring lines.

e. Under calm sea conditions (Sea State 0-1) LCUs can be married to a B section attached to the CPF. The process becomes increasingly difficult, if not impossible, as winds and currents increase (Sea State 2). The addition of a Causeway Ferry to the CPF aids the marriage process, especially during periods of increased wind and current.

f. The addition of a B section and LCU increases the forces on the CPF mooring lines.

g. NSS RO/RO operations utilizing side ports will be more difficult and time-consuming compared to stern ports or self-sustaining RO/ROs with ramps facing astern. For those NSS RO/ROs with both side ports and stern ports, only stern ports should be used for offshore operations.

5.0 RECOMMENDATIONS

Based on the discussion items in Sections 2 and 3 the following design improvements are recommended:

a. The edges of the polyethylene foot pads of the CWR be beveled at a 45-deg angle to facilitate movement of the CWR on wood dunnage.

b. The fender support structure (pipes behind the foam-filled fenders) should be reduced in overall length by approximately 1 ft to prevent damage during CPF mooring.

c. Using the test data, mooring procedures should be updated to ensure that an adequate number of lines are provided to accommodate the "worst case" mooring situation.

d. A special set of padeyes should be installed on the ramp to allow

it to be pulled away from the ship while the hinged ramp flaps are in the up/stored position.

Operational testing using an actual NSS RO/RO ship should be performed in order to check those areas which could not be examined in these tests, including raising the CWR with the ship's winches and vehicle offloading using the ramp.

6.0 REFERENCES

1. J.J. Henry Report 1969-00-A, "Offloading Military Cargo From Roll-On/Roll-Off (RO/RO) Merchant Ships" (12 May 1981).

2. DTNSRDC/SPD 1046-01, "Model Experiments of RO/RO Ships Offloading System in Waves and Current" (Dec 1982).

3. NCEL TM55-83-04, "COTS-RO/RO Ship Discharge Facility Assembly Tests" (Apr 1983).

4. DTNSRDC/SDD-83/2, "RO/RO (Roll-On/Roll-Off) Merchant Vessel Offloading Facility Tests with MS CYGNUS (COTS CNO Project 299, DT-IM-3, Conducted 23-27 September 1982" (Mar 1983).

5. NAVFAC P-3-023, Technical Manual "COTS Causeway Platform Facility (CPF) and Calm Water Ramp (CWR)" (Preliminary).

6. DTNSRDC/SPD-515-03, "MS CYGNUS, SS AMERICAN TROJAN, and Causeway Platform Facility Relative Motions Evaluation" (Feb 1983).

Figure 1 - SS AMERICAN TROJAN at Anchor

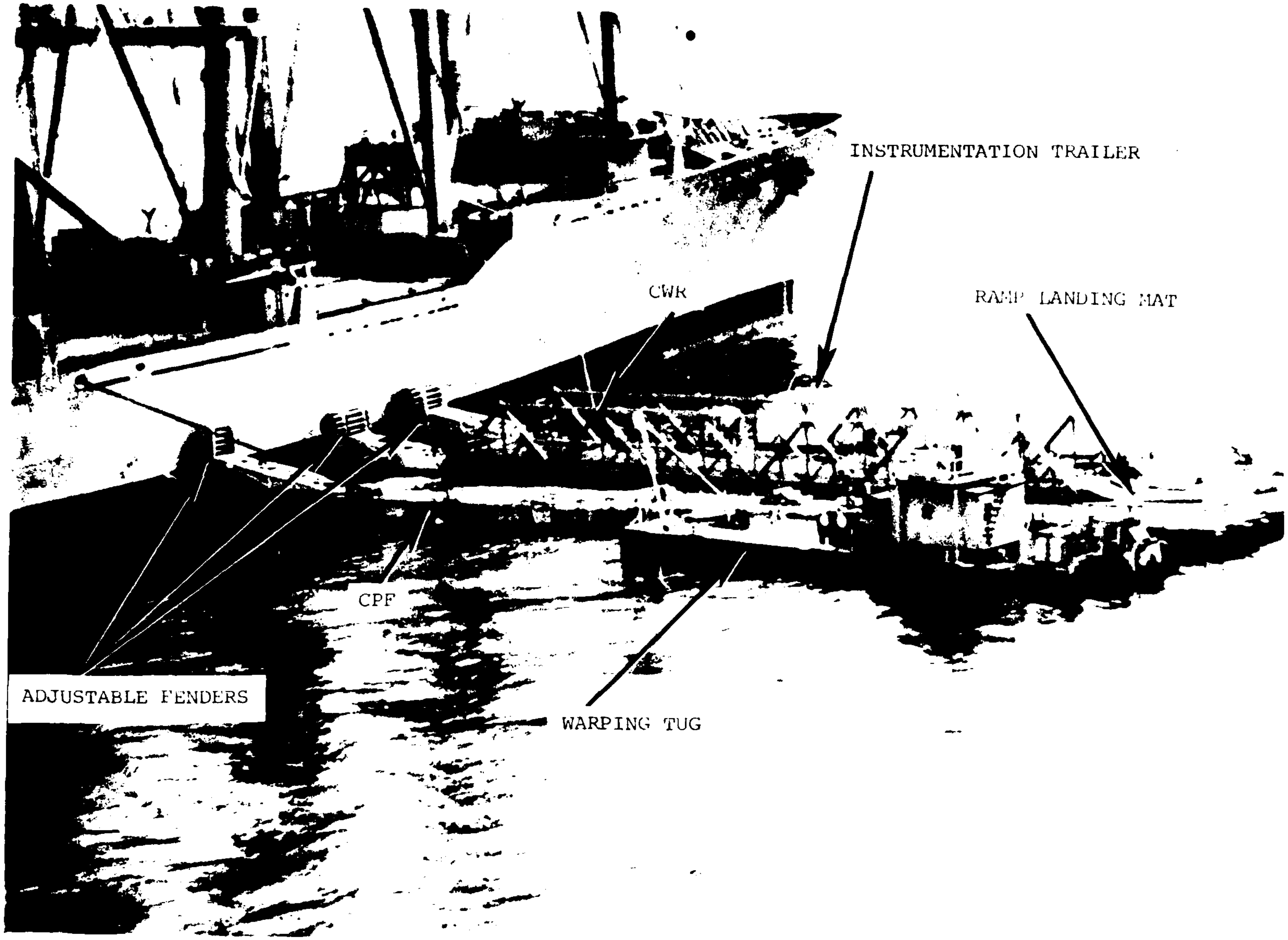

Figure 2 - CPF Moored Alongside SS AMERICAN TROJAN

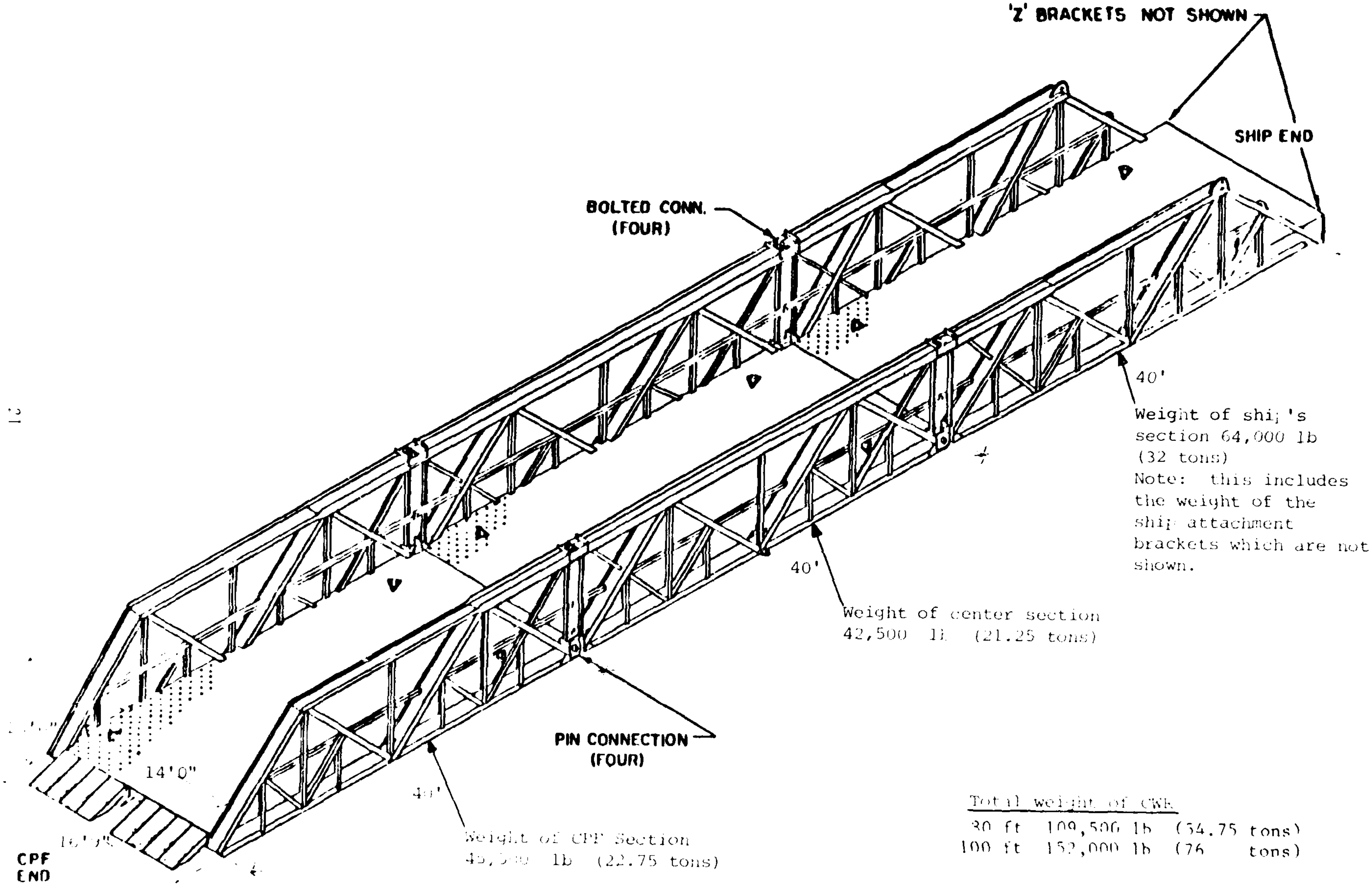

Figure 3 - Calm Water Ramp (CWR)

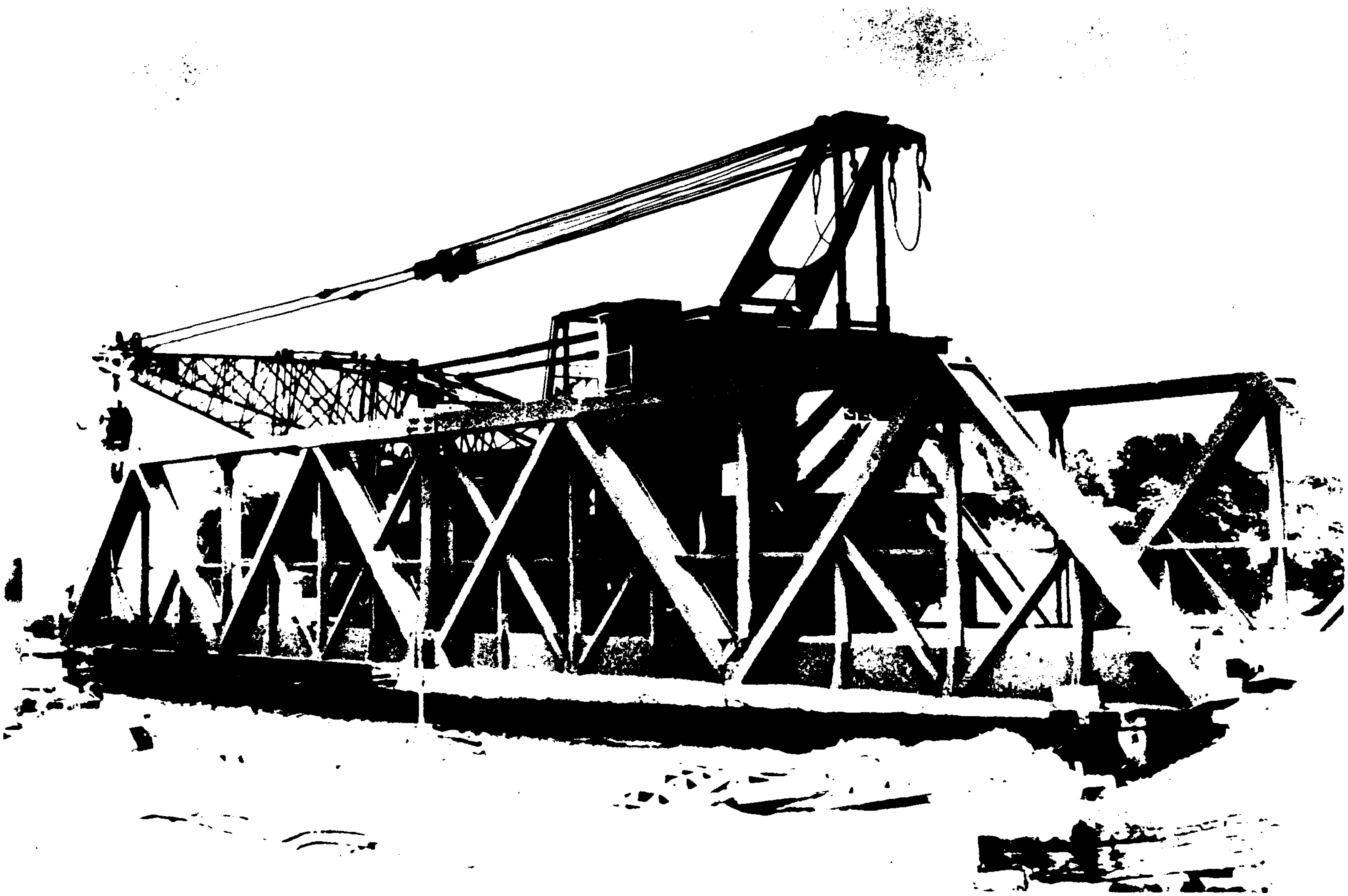

Figure 4 - Dynamic Load Testing of CWR in 80-ft Configuration

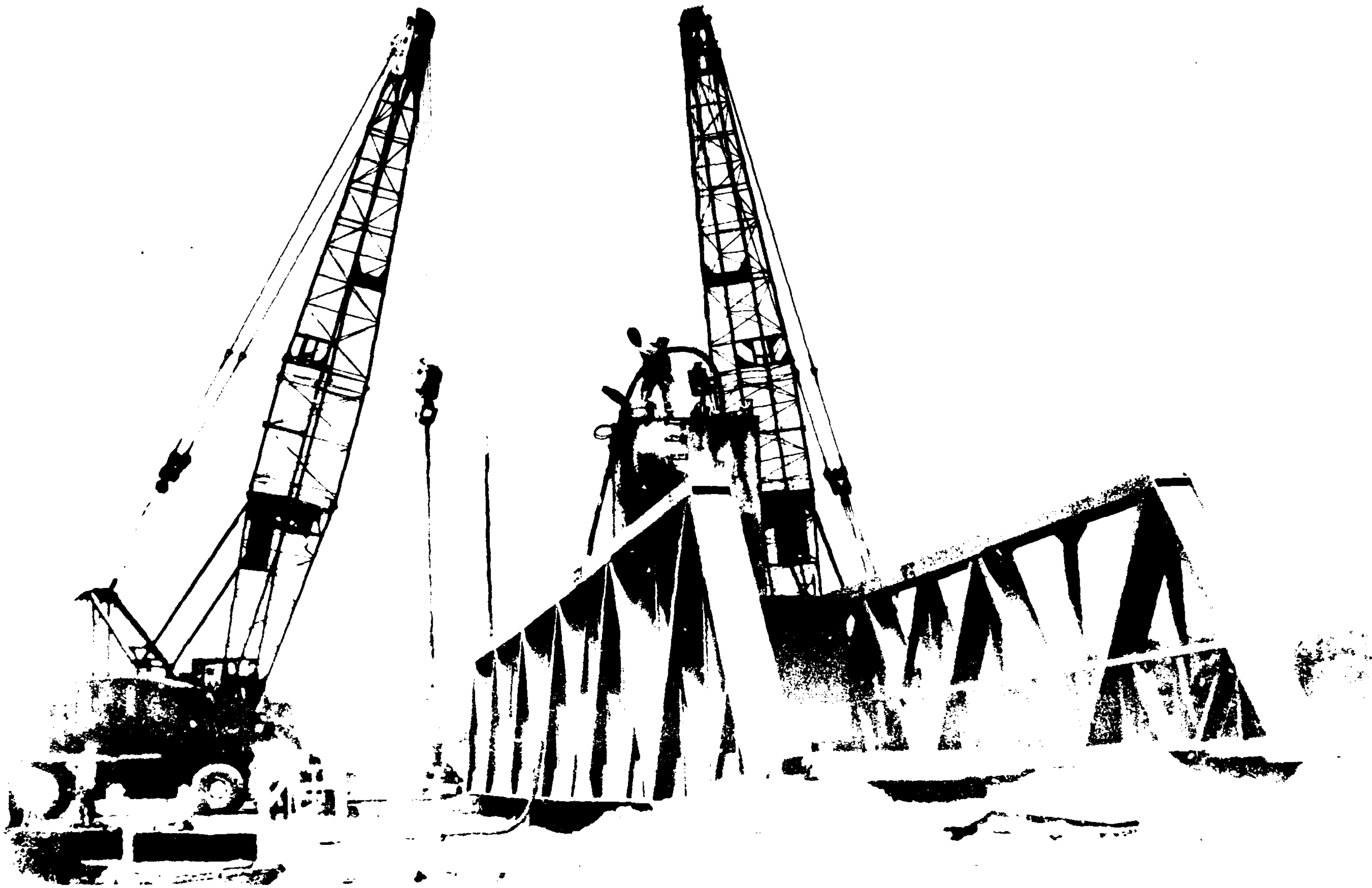

Figure 5 - Static Load Testing of CWR in 120-ft Configuration

Figure 6 - Lifting Sling Arrangement for 15° Incline Test

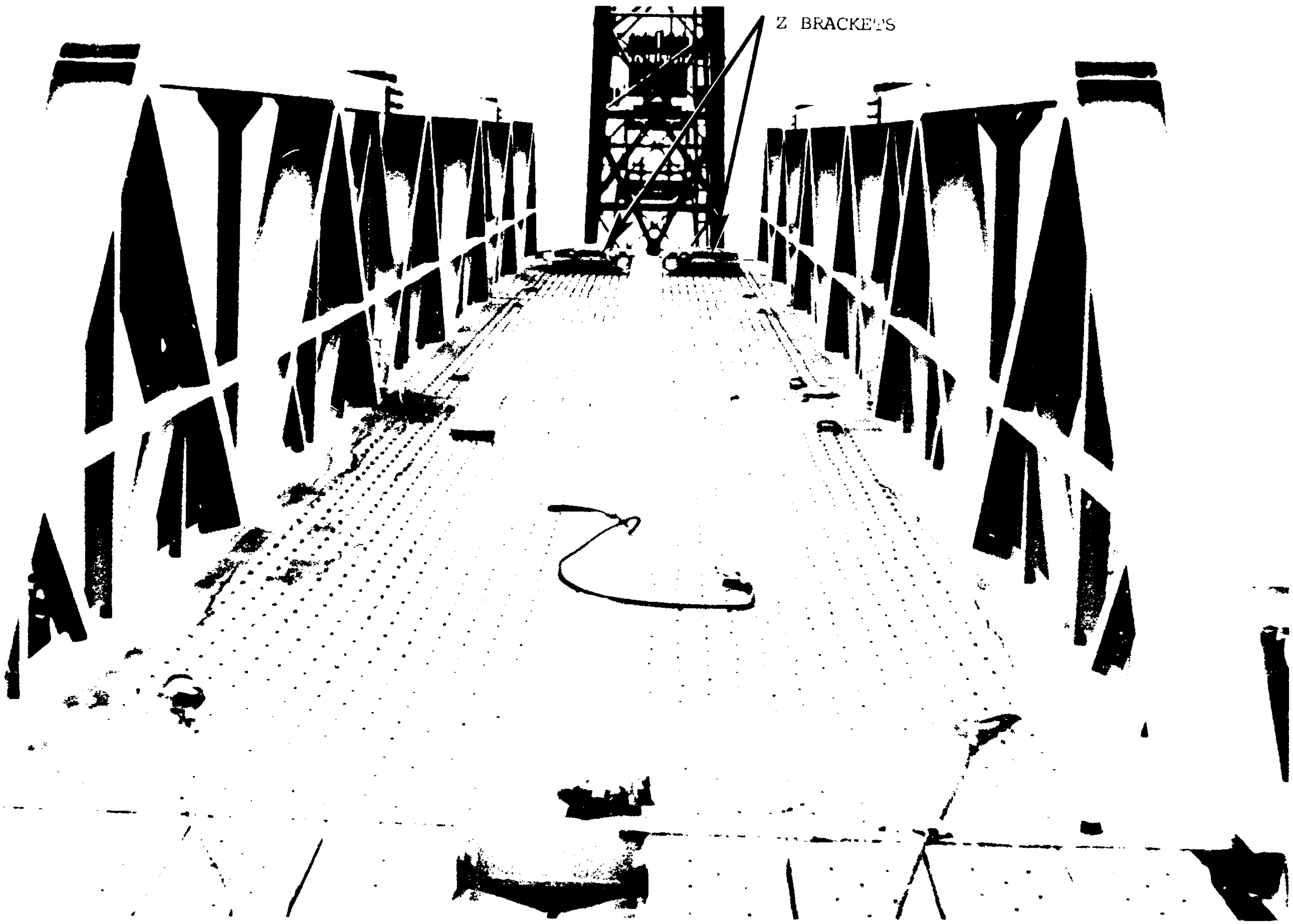

Figure 7 - CWR with "Z" Brackets on Ramp Deck

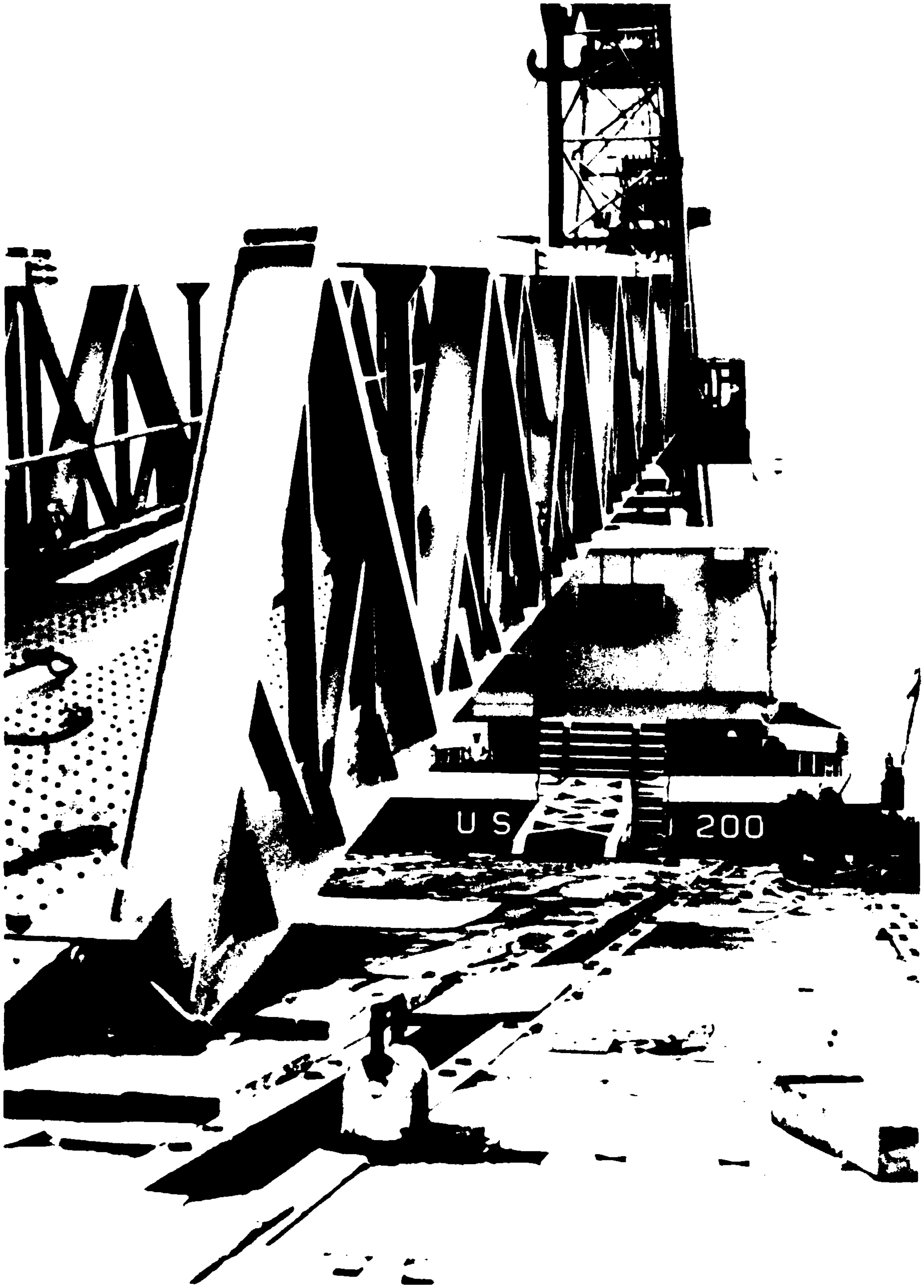

Figure 8 - CWR Lifted to 15° Angle

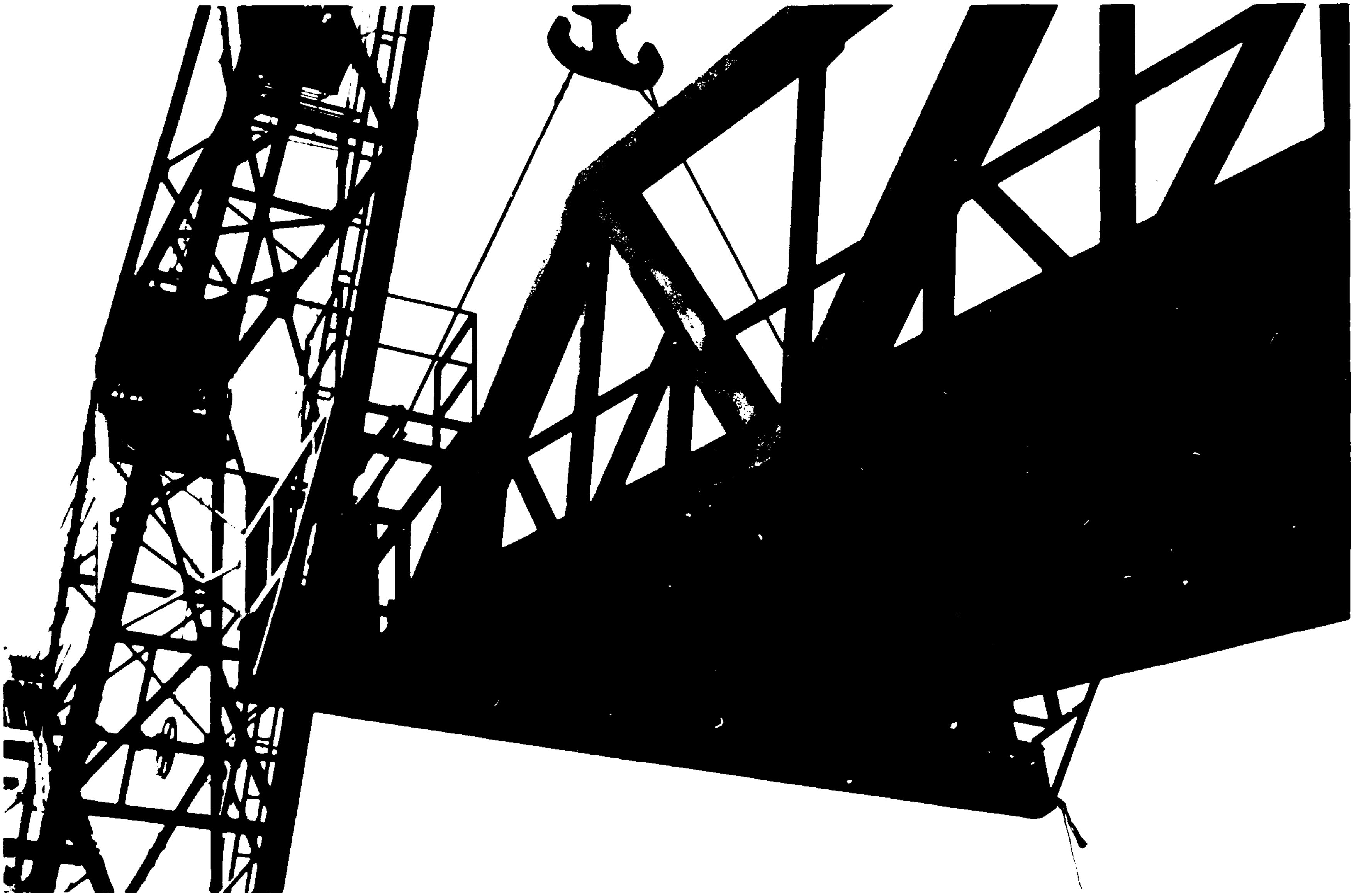

Figure 9 - CWR Being Lifted by YD Crane

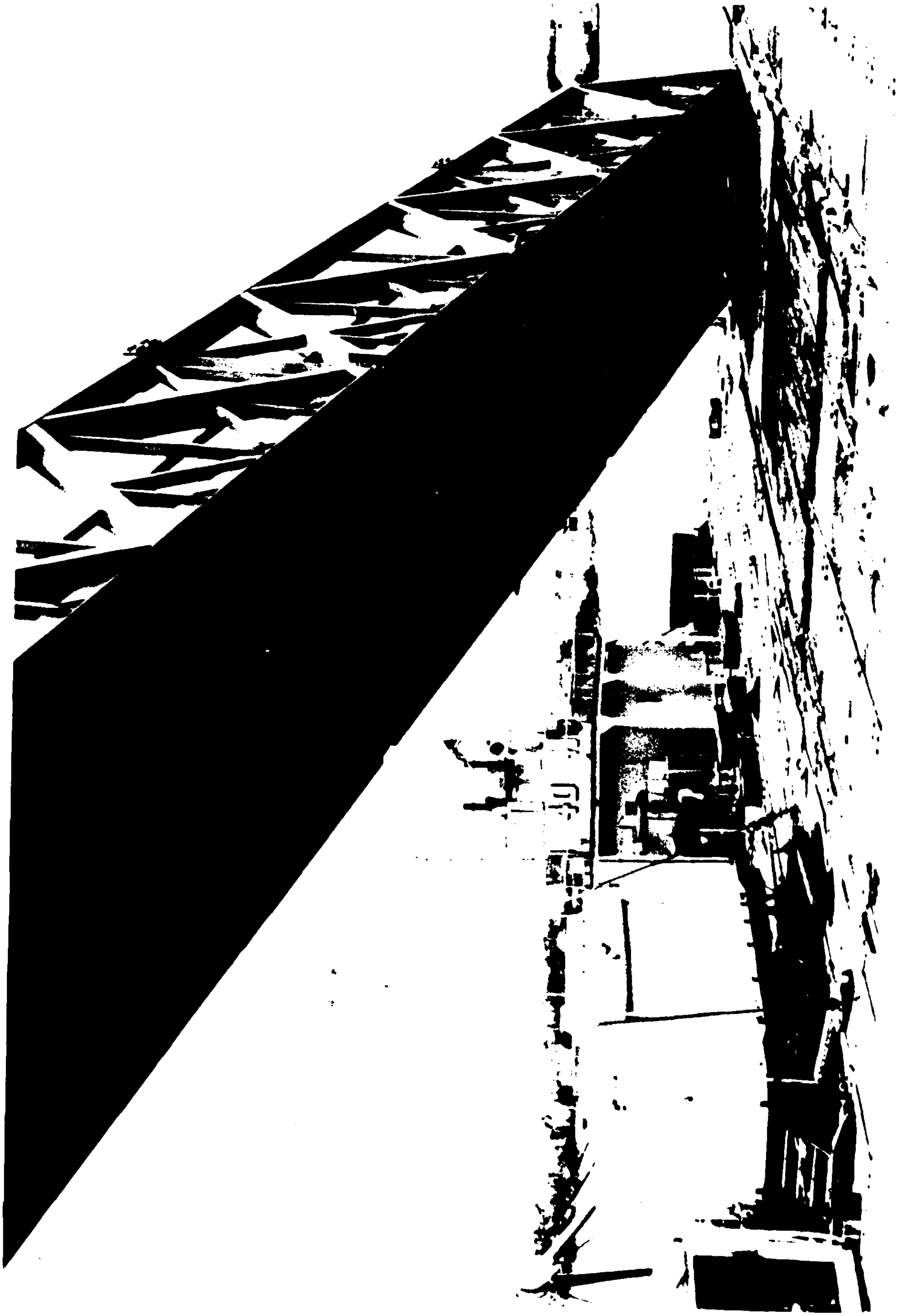

Figure 10 - CWR at 15° Angle

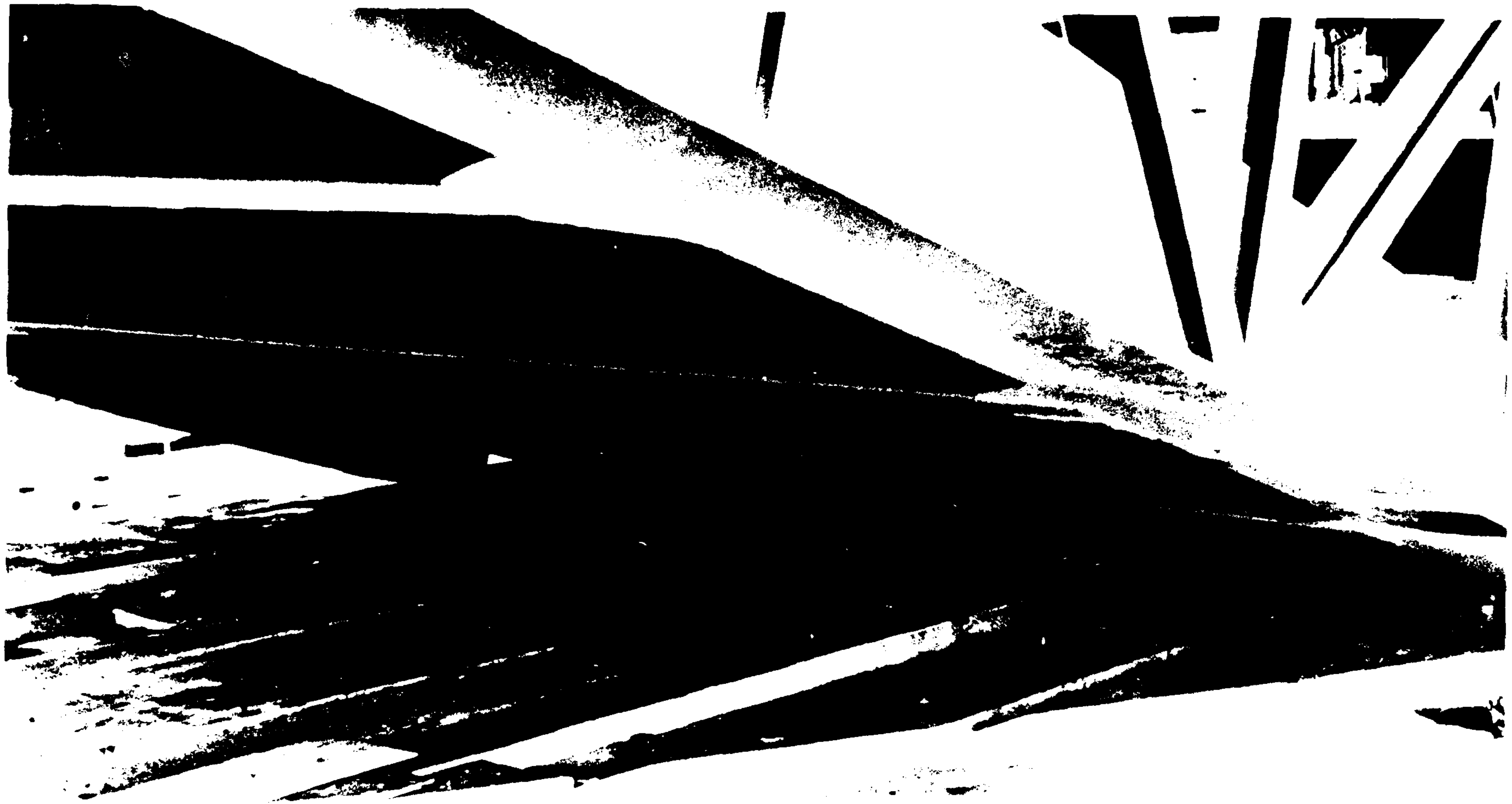

Figure 11 - Ramp Shoes Resting on Dunnage

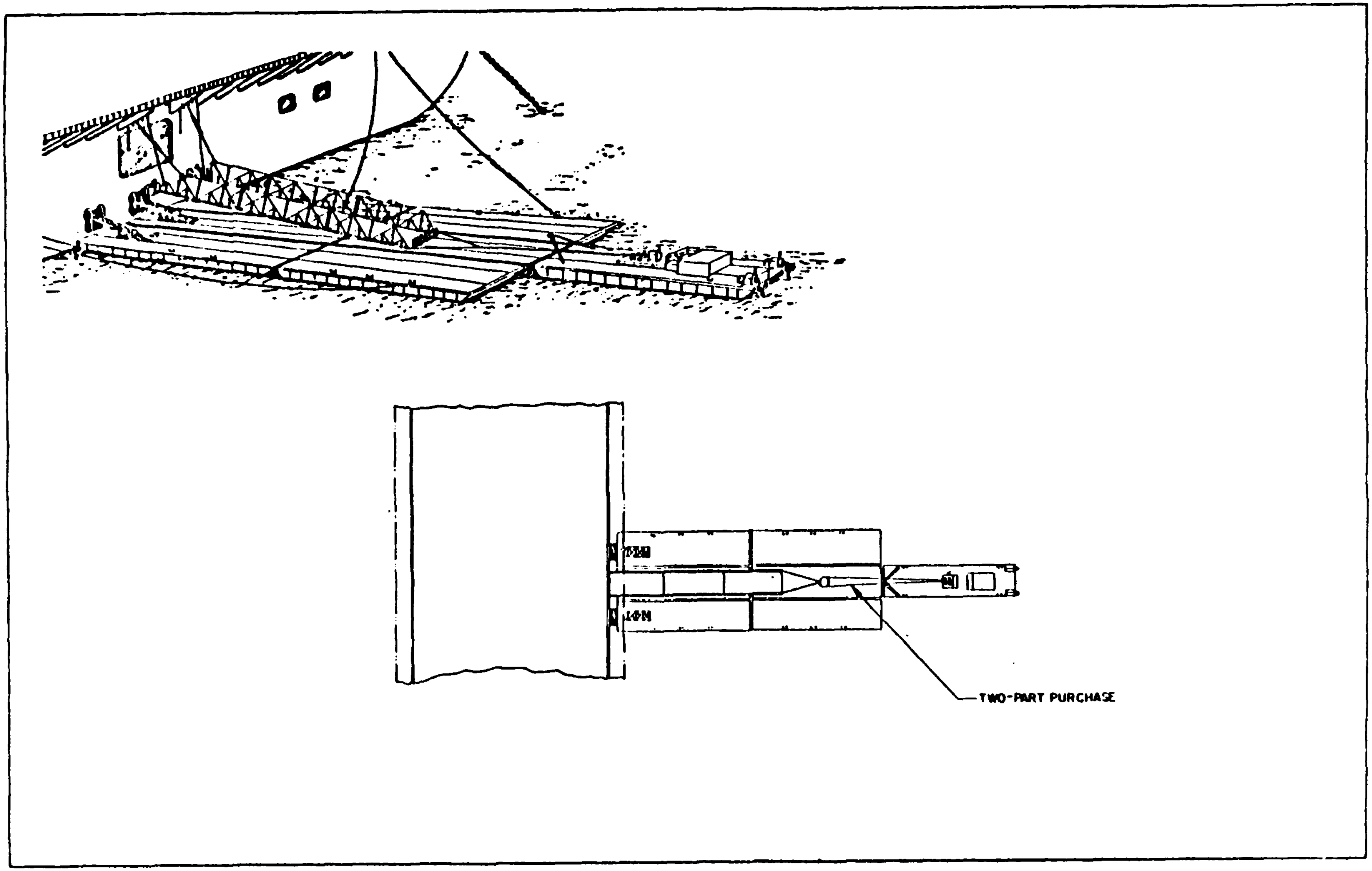

Figure 12 - Using Warping Tug Winch to Pull CWR From Ship

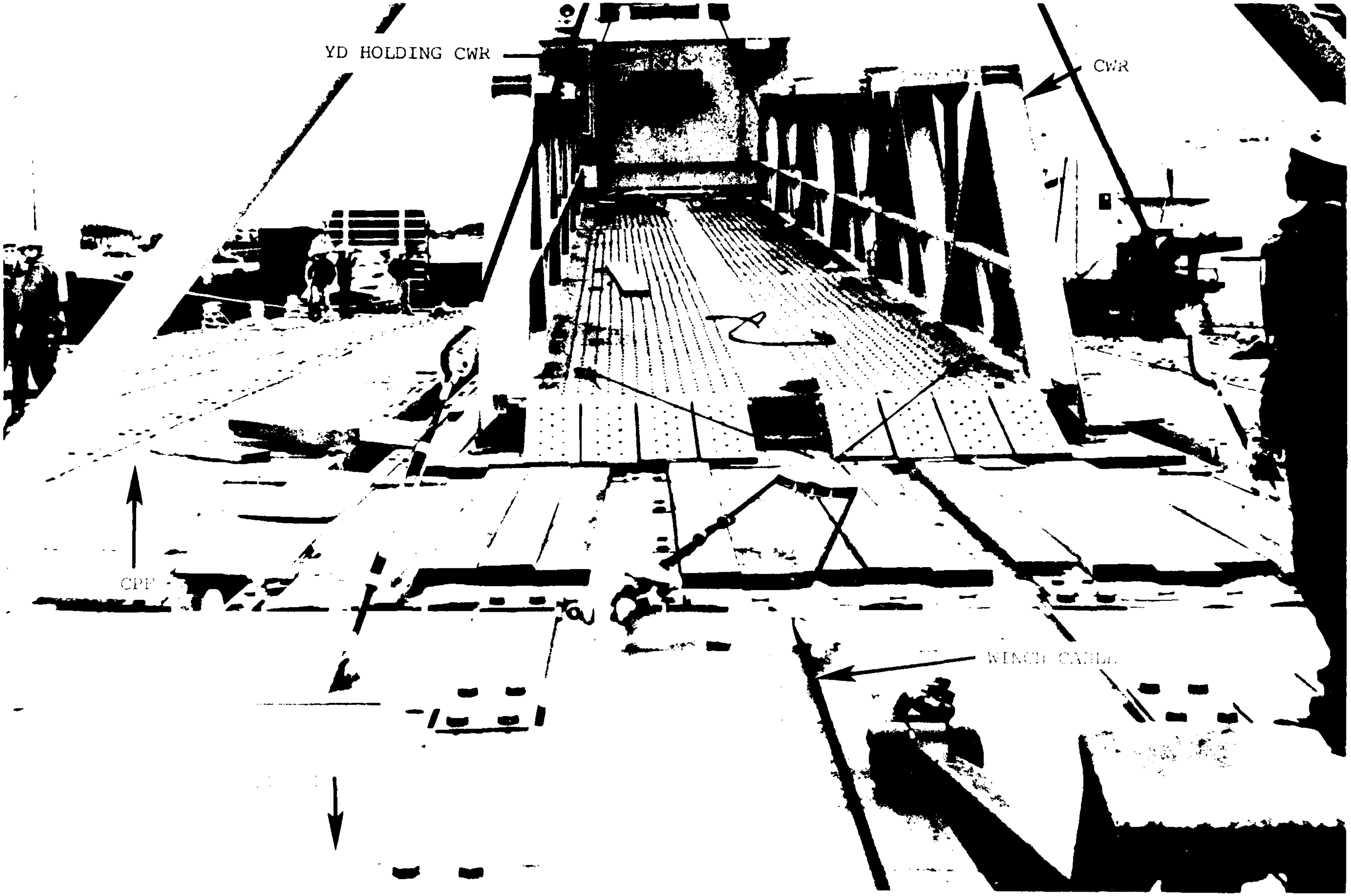

Figure 13 - CWR Being Pulled Back with Warping Tug Winch

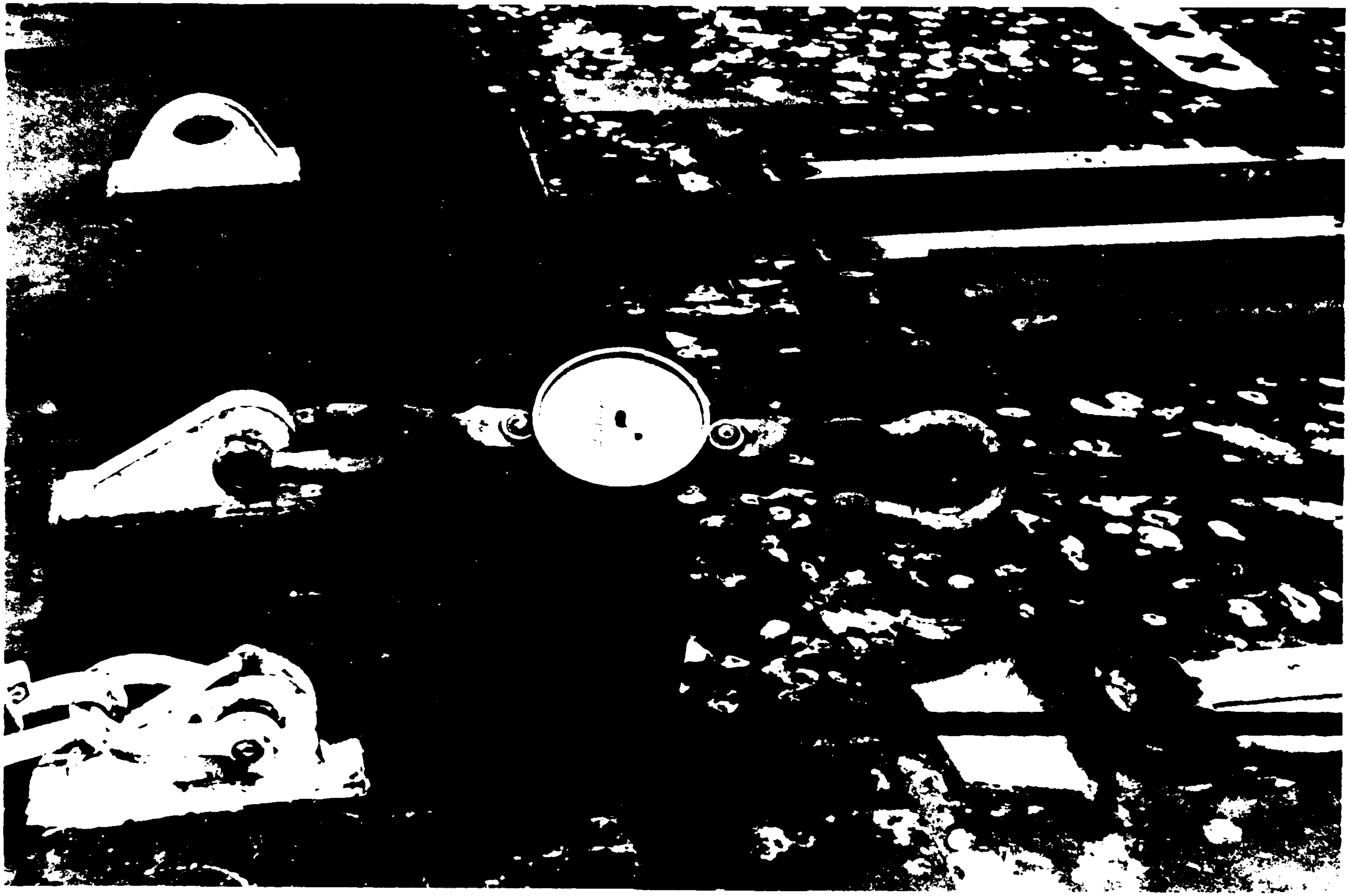

Figure 14 - Dynamometer Reading During CWR Pull Test

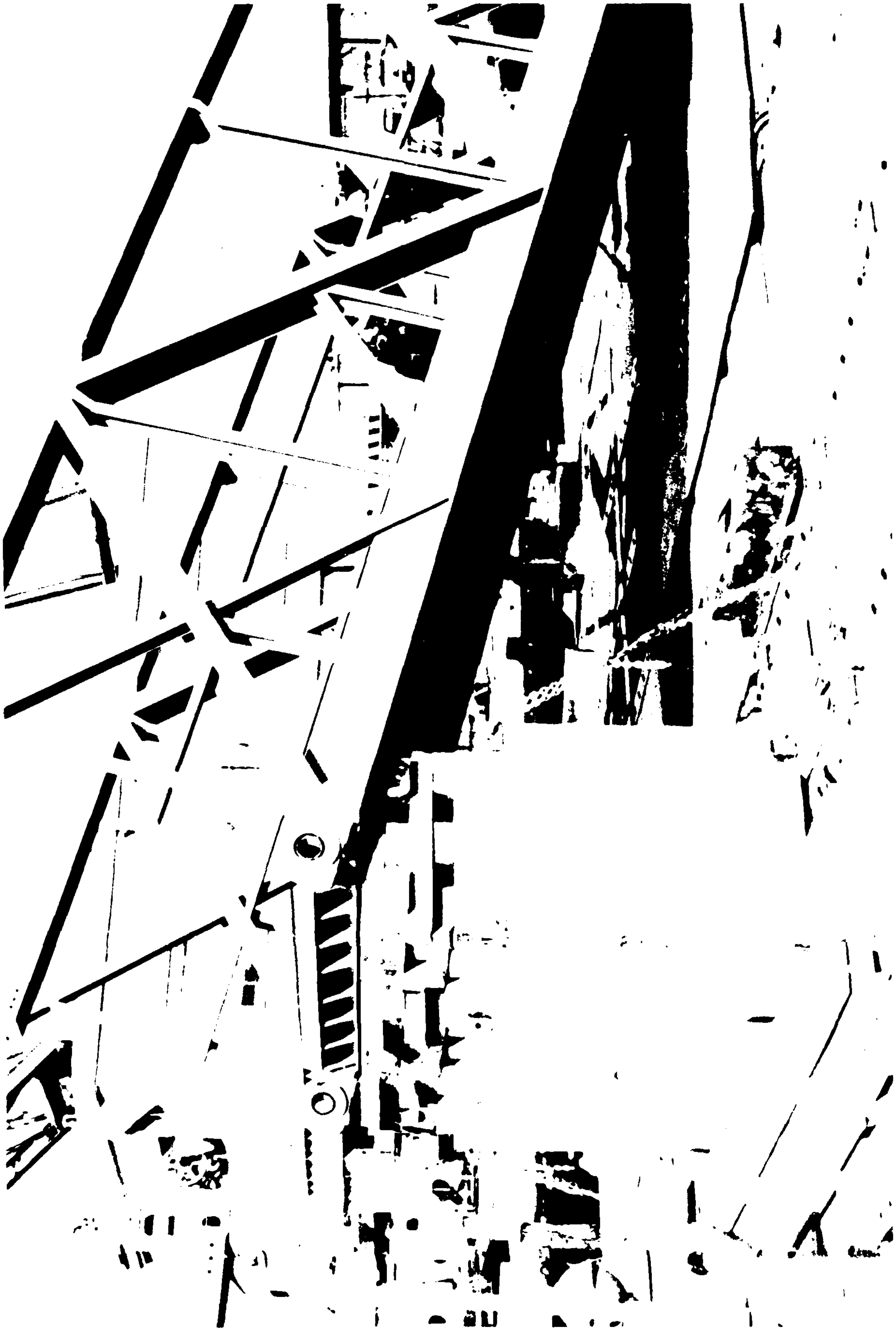

Figure 15 - Ramp Incline Test Setup

Figure 16 - LVTP7 on Inclined Ramp (View 1)

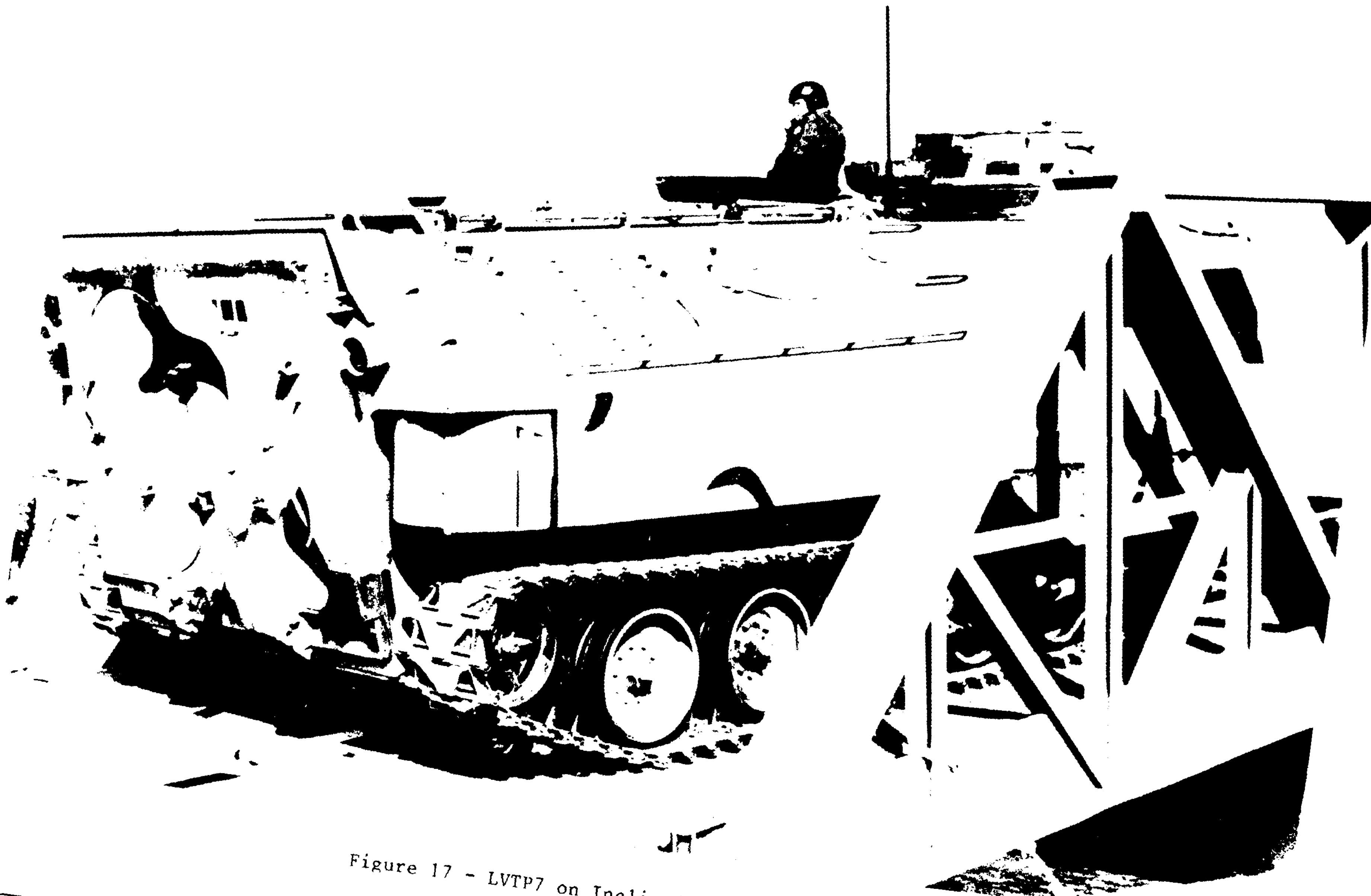

Figure 17 - LVTP7 on Inclined Ramp (View 2)

Figure 18 - LVTP7 Clearance on Left Side

Figure 19 - LVTP7 Clearance on Right Side

Figure 20 - Effects of Driving on Traction Studs

Figure 21 - Tread Damage From Traction Studs

Figure 22 - M48 Tank on Inclined Ramp

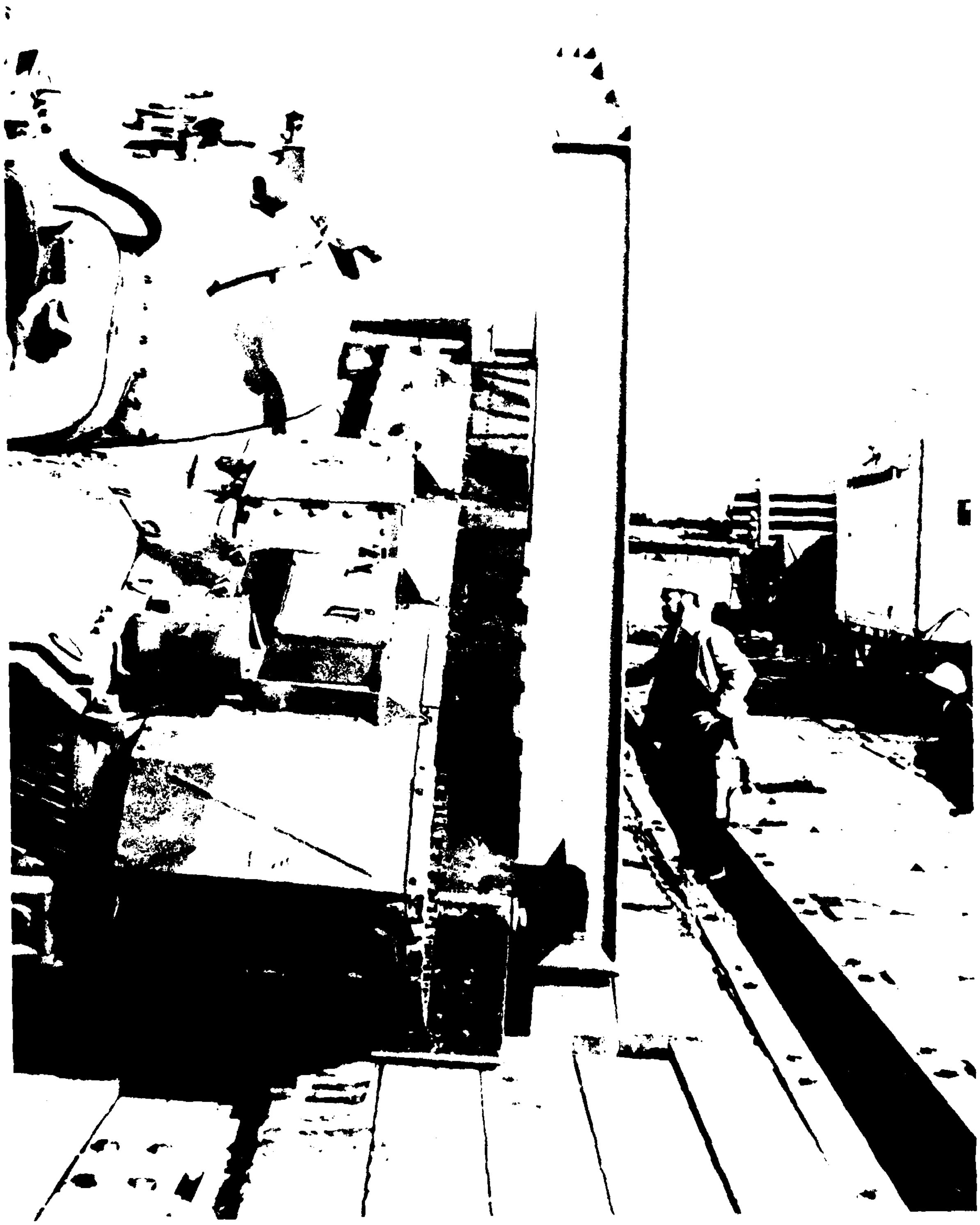

Figure 23 - M48 Tank Clearance on Right Side

Figure 24 - M48 Tank Clearance on Left Side

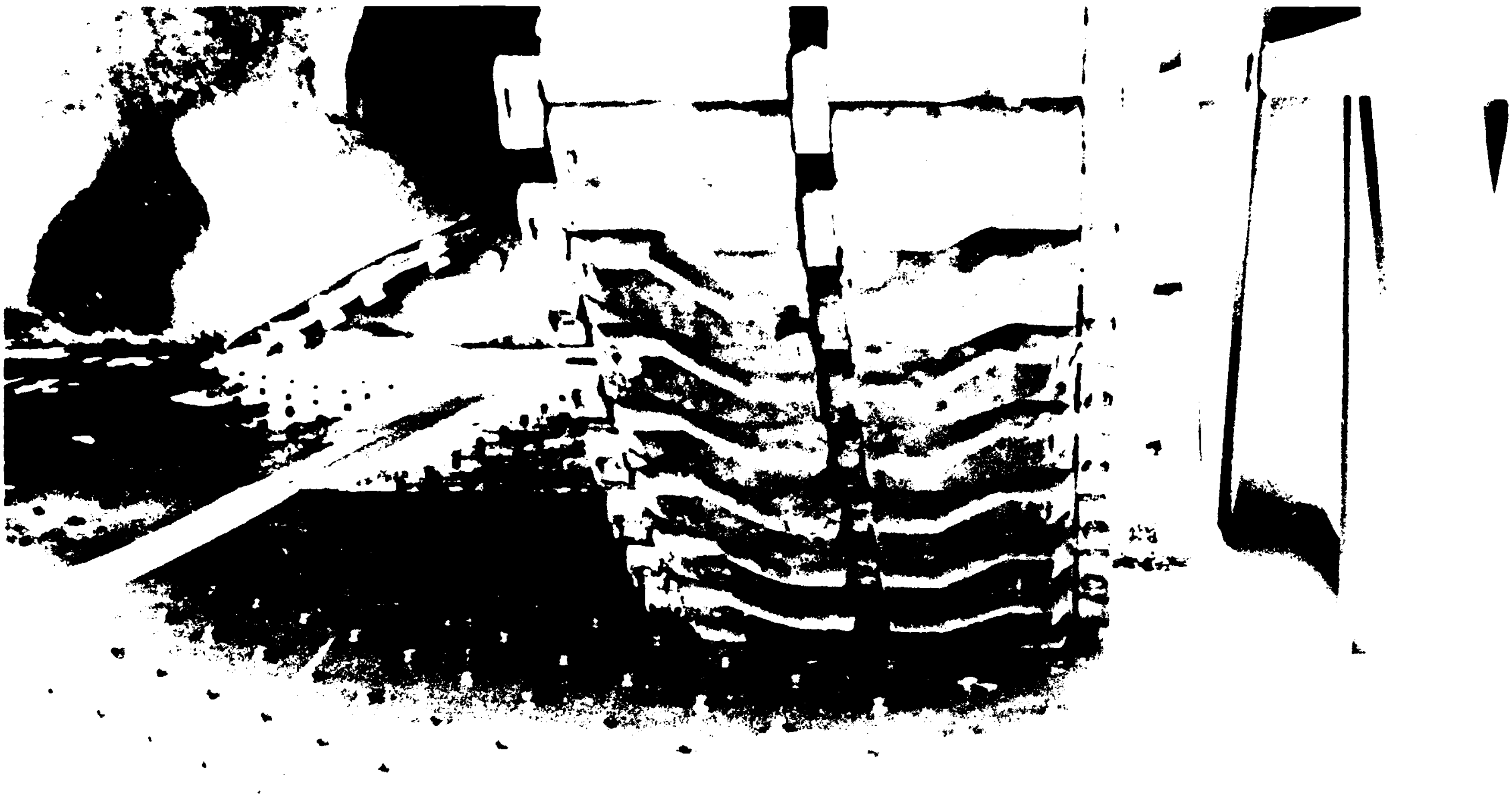

Figure 25 - M48 Tank Pads on Traction Studs (No Damage to Treads)

Figure 26 - M35 on Inclined Ramp (View 1)

Figure 27 - M35 on Inclined Ramp (View 2)

Figure 28 - M35 on Inclined Ramp (View 3)

Figure 29 - M35 Clearance on Right Side

Figure 30 - M35 Clearance on Left Side

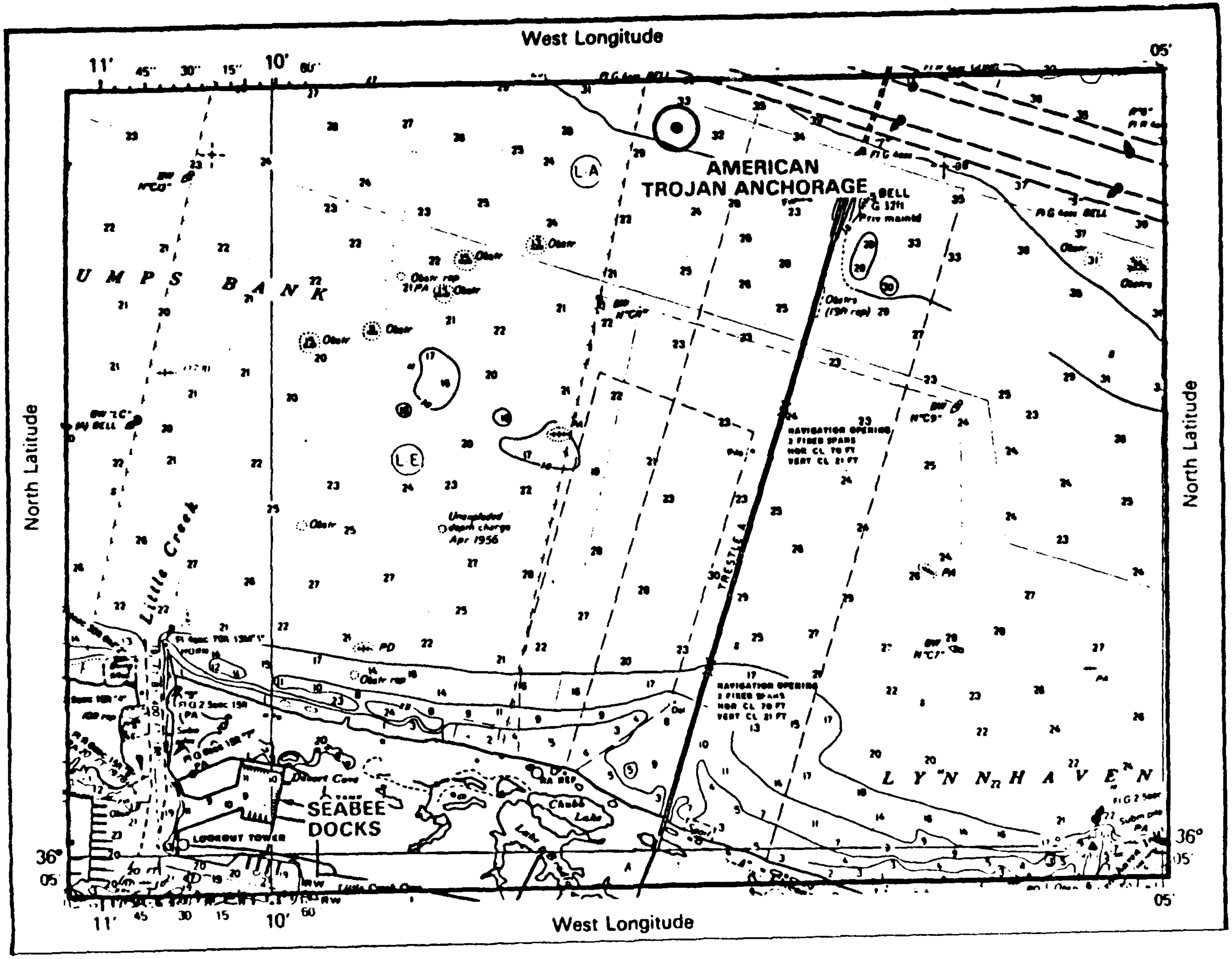

Figure 31 - Nautical Chart of Norfolk-Virginia Beach (Chesapeake Bay) Test Setting

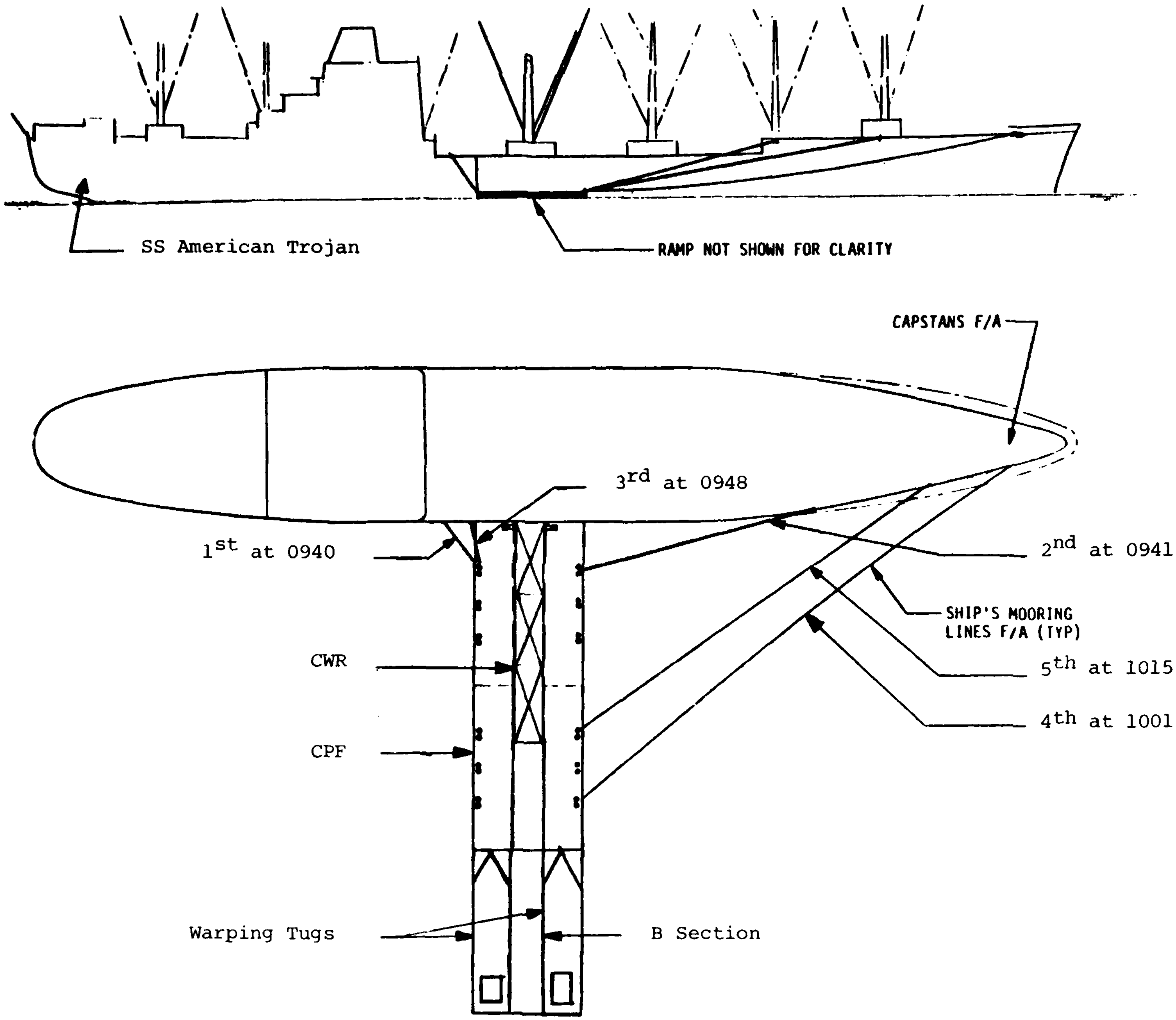

Figure 32 - CPF Mooring Sequence and Times for 17 Nov 1982

Figure 33 - CPF Approaching SS AMERICAN TROJAN

Figure 34 - CPF Leeward Side Mooring Attachment

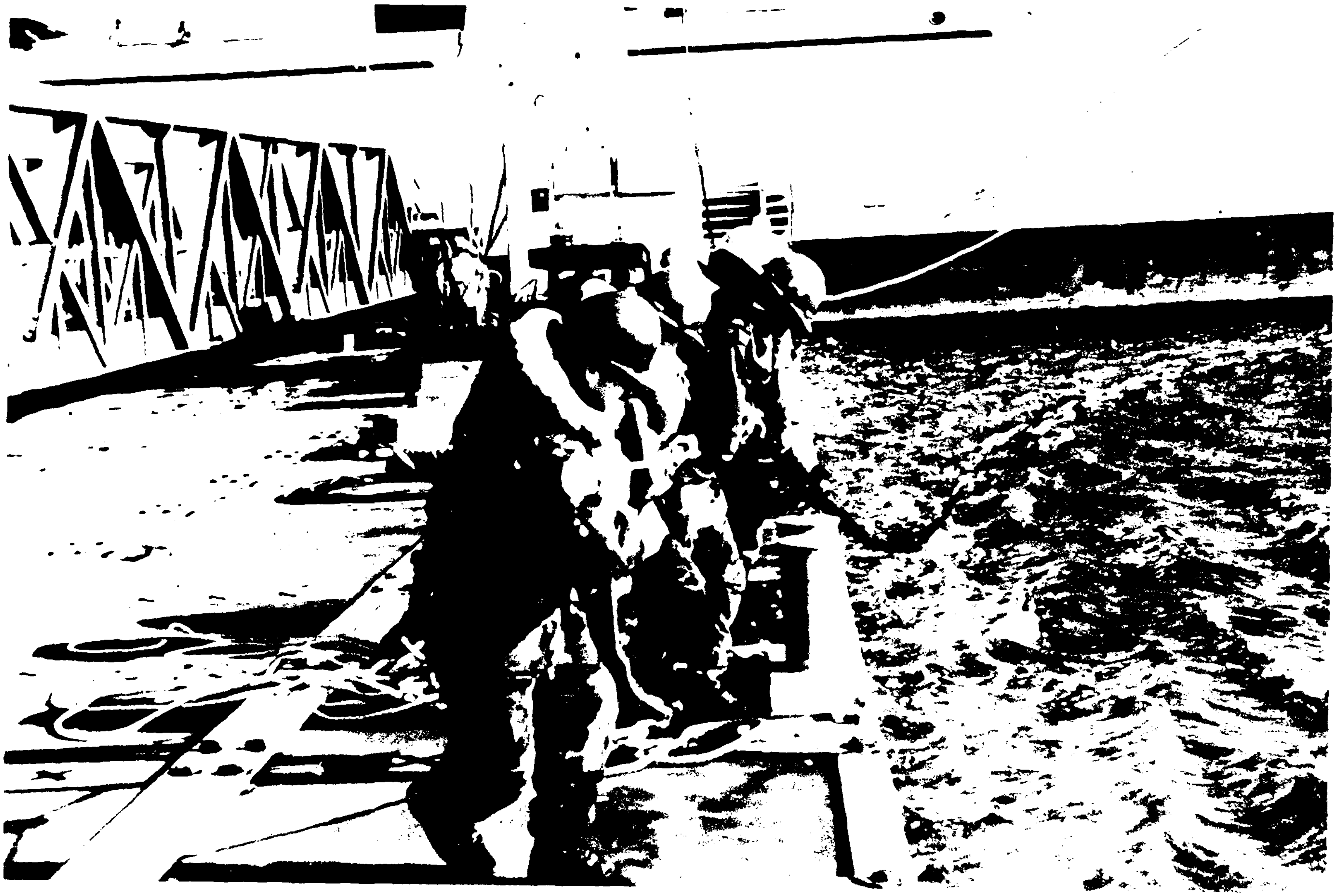

Figure 35 - Crew Pulling Line to Last Set of Bitts

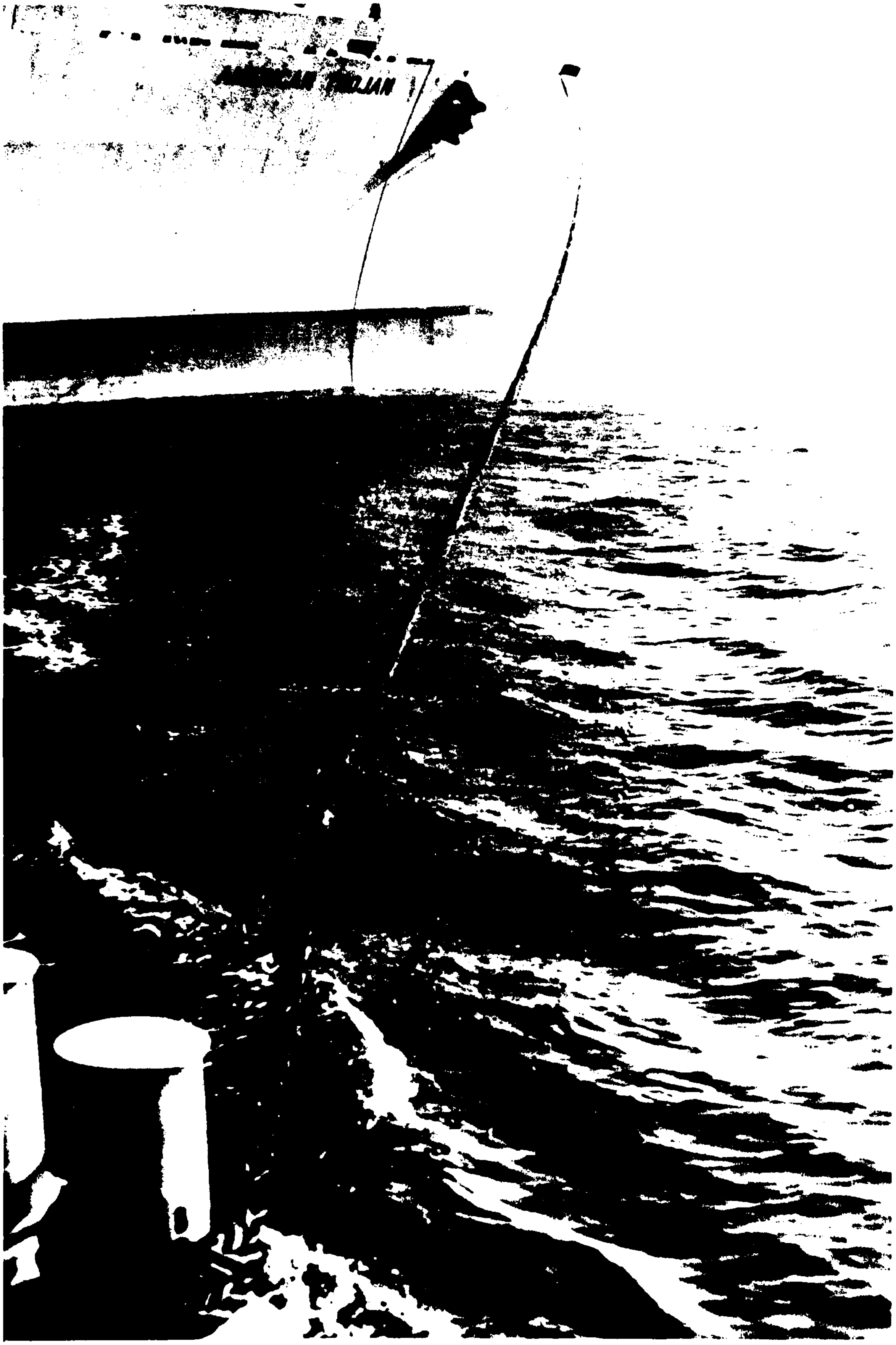

Figure 36 - Lines Being Pulled Taut by Ships' Winch

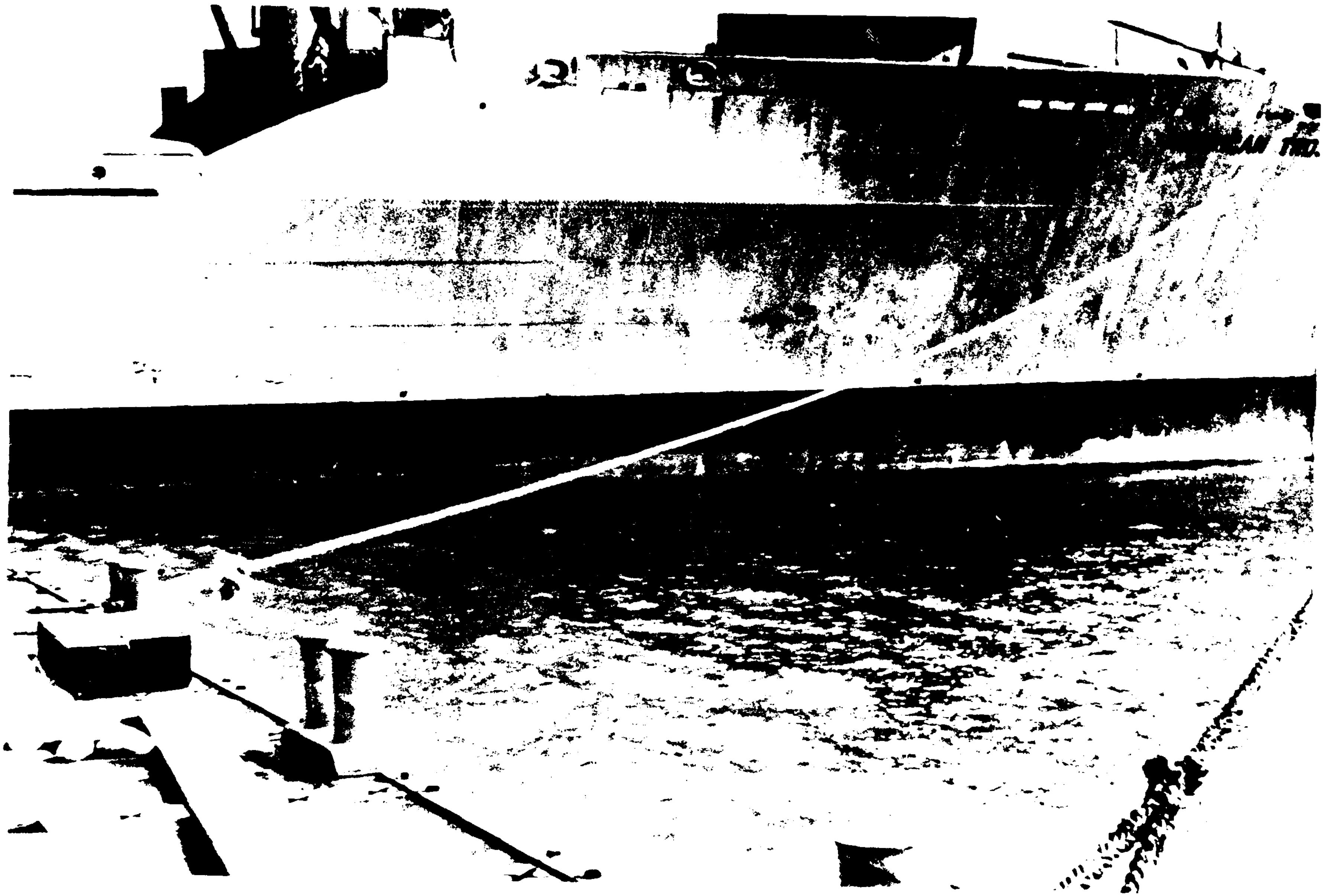

Figure 37 - Windward/Current Side Mooring Arrangement

Figure 38 - CPF Approaching at an Oblique Angle

Figure 39 - CPF Contacting Ship

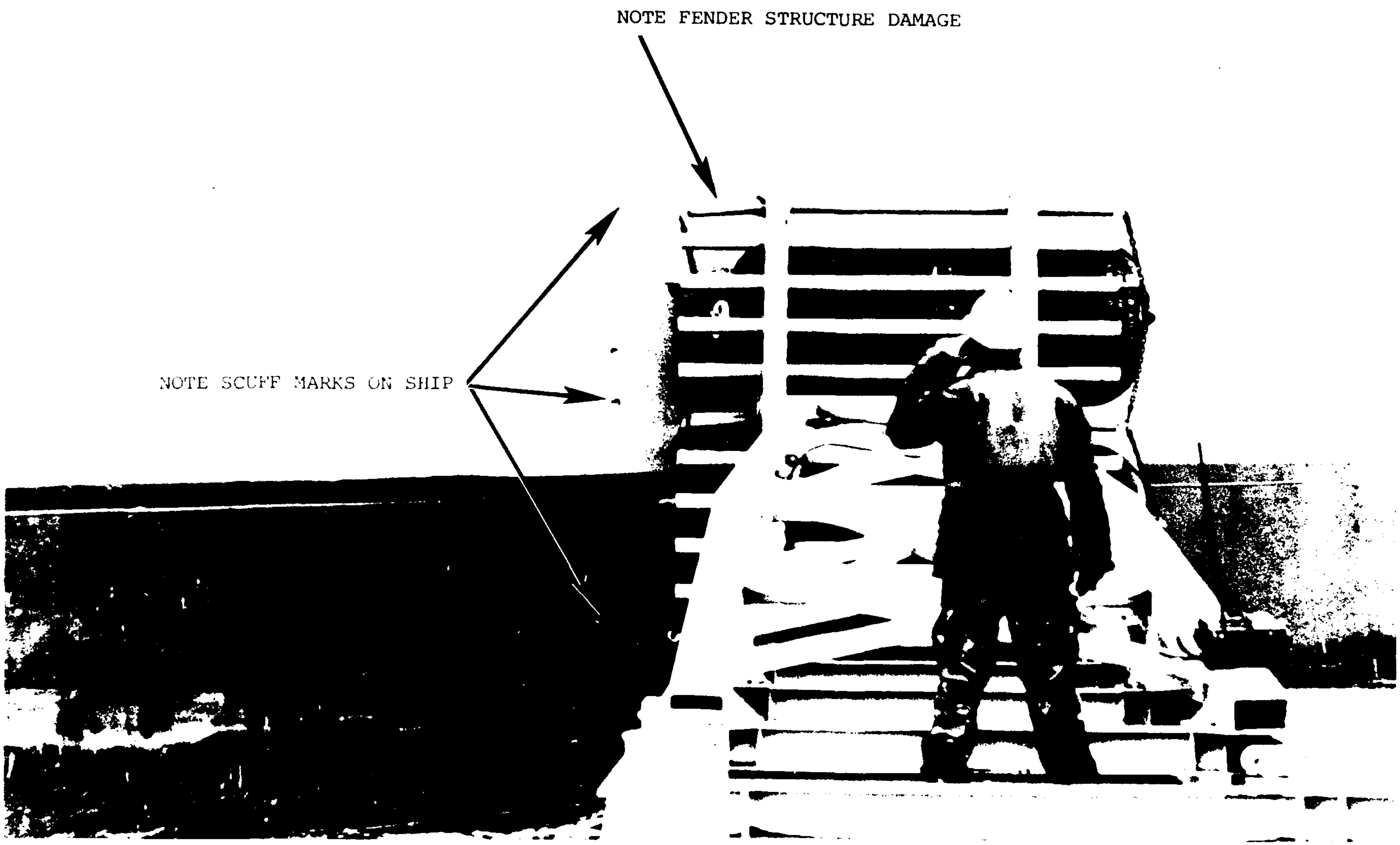

Figure 40 - CPF Forward Motion Stopped

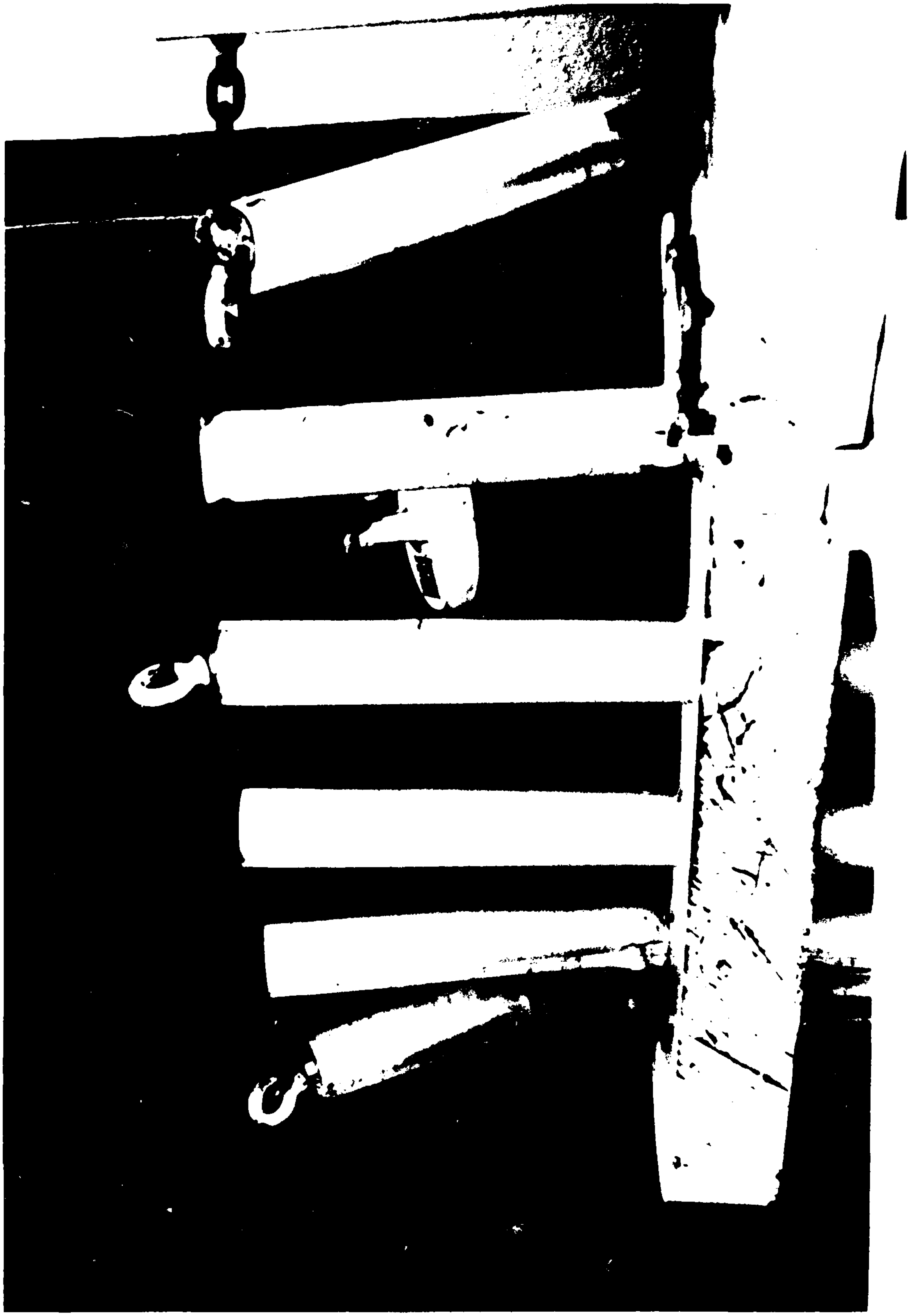

Figure 41 - Result of Fender Contact with Ship (View 1)

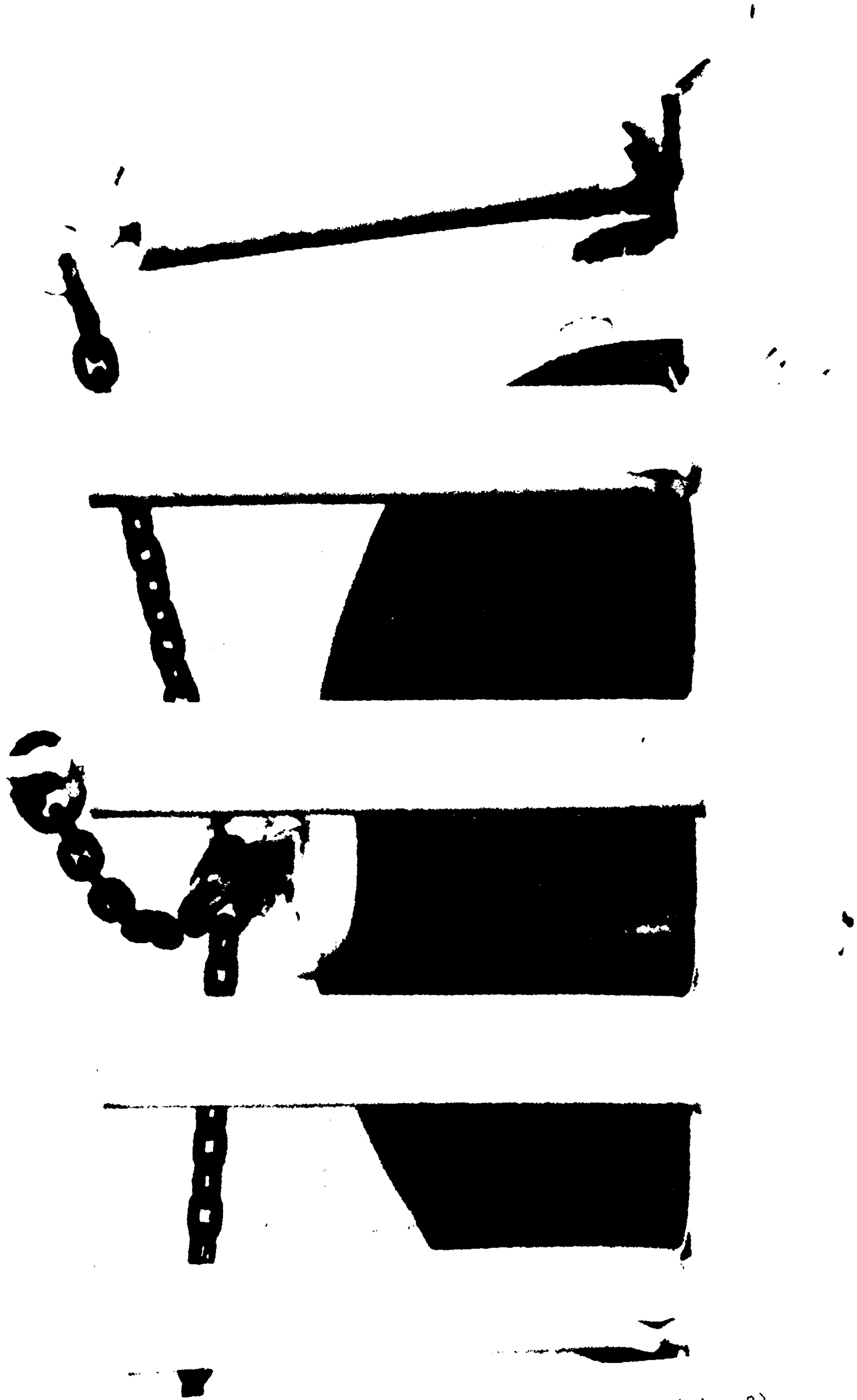

Figure 42 - Result of Fender Contact with Ship (View 2)

Figure 43 - CPF Fenders Against Ship on 17 November

Figure 44 - Close-up of Individual Fender Configuration

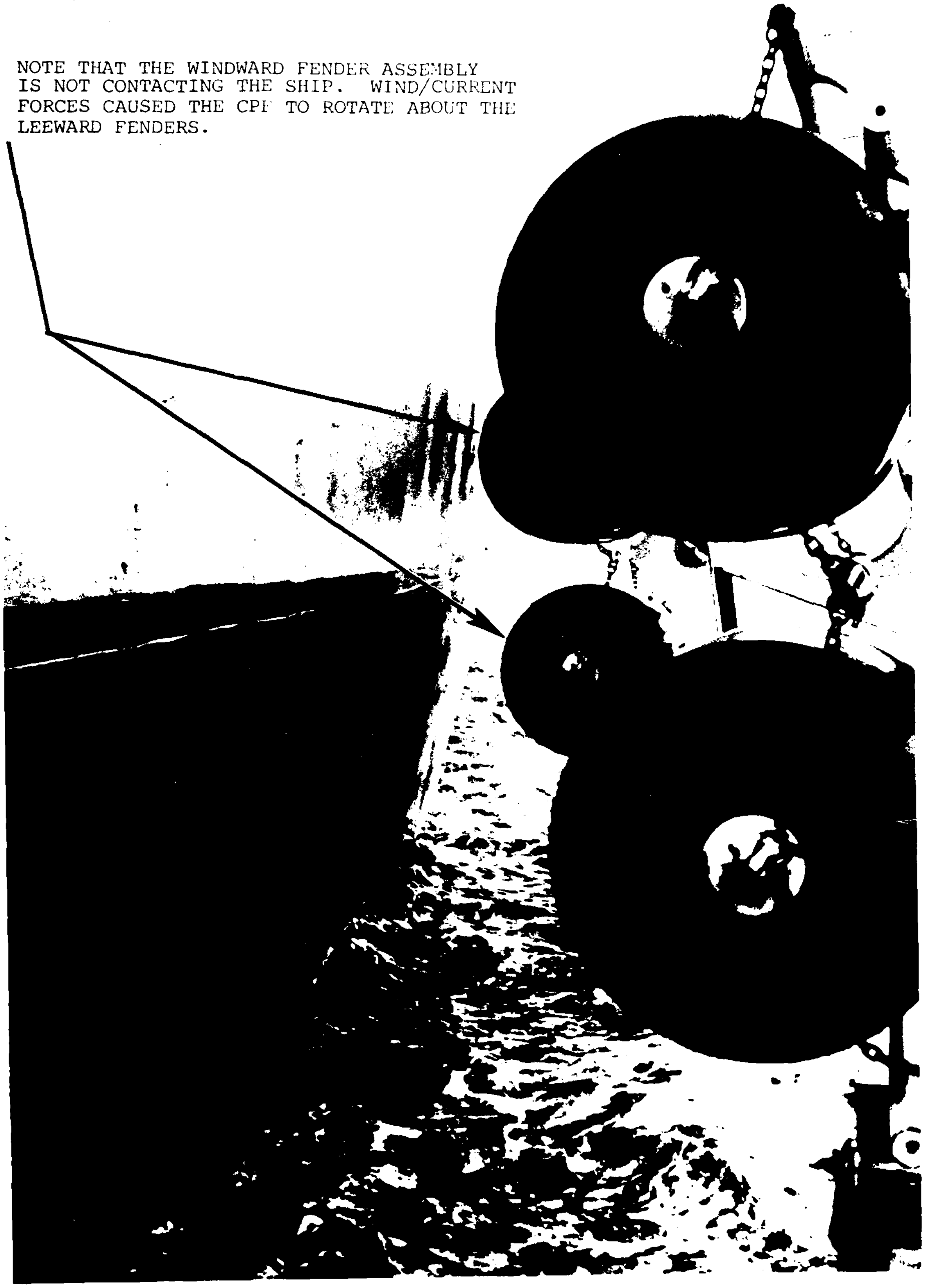

Figure 45 - Windward CPF Fender Assembly

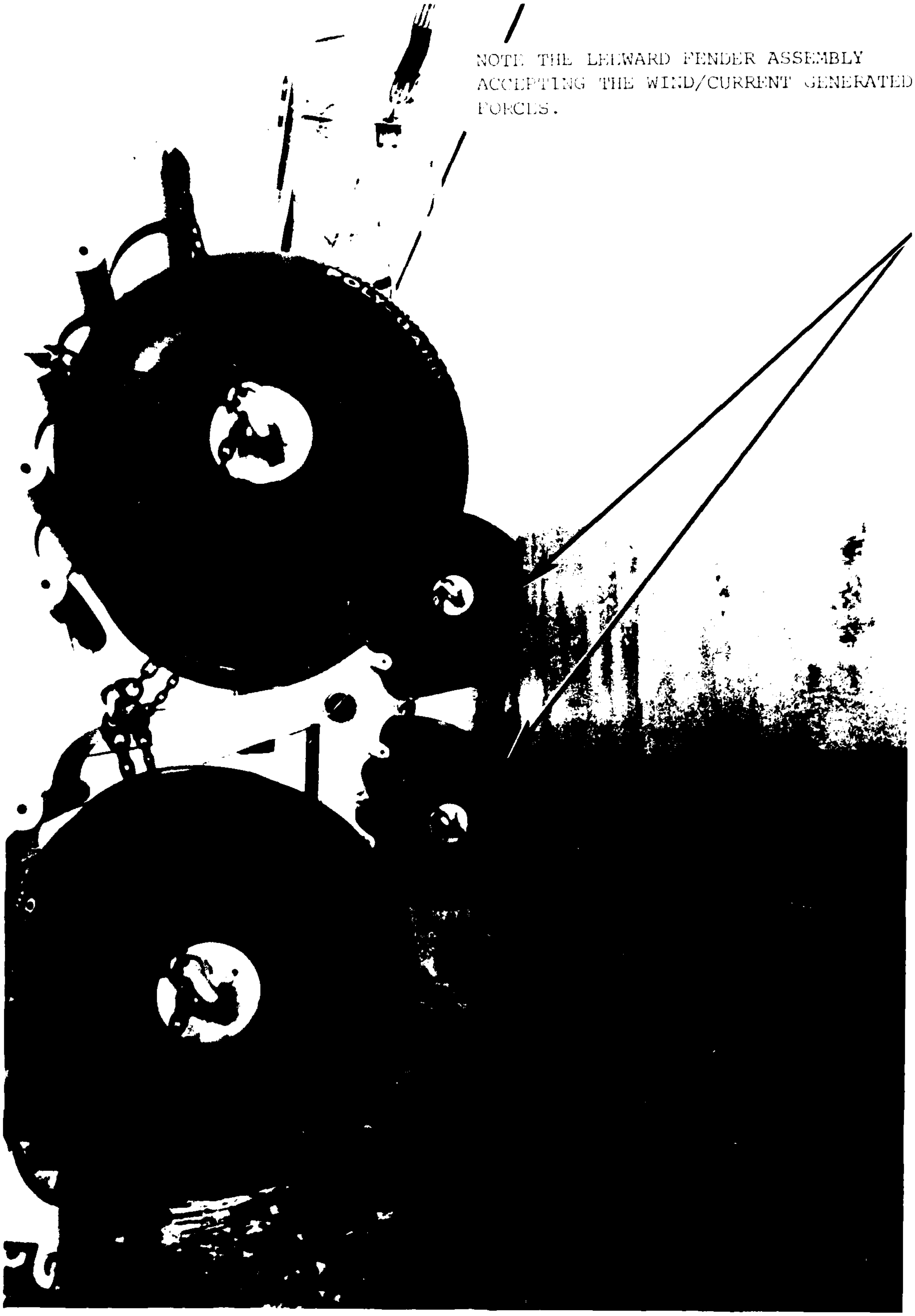

Figure 46 - Leeward CPF Fender Assembly

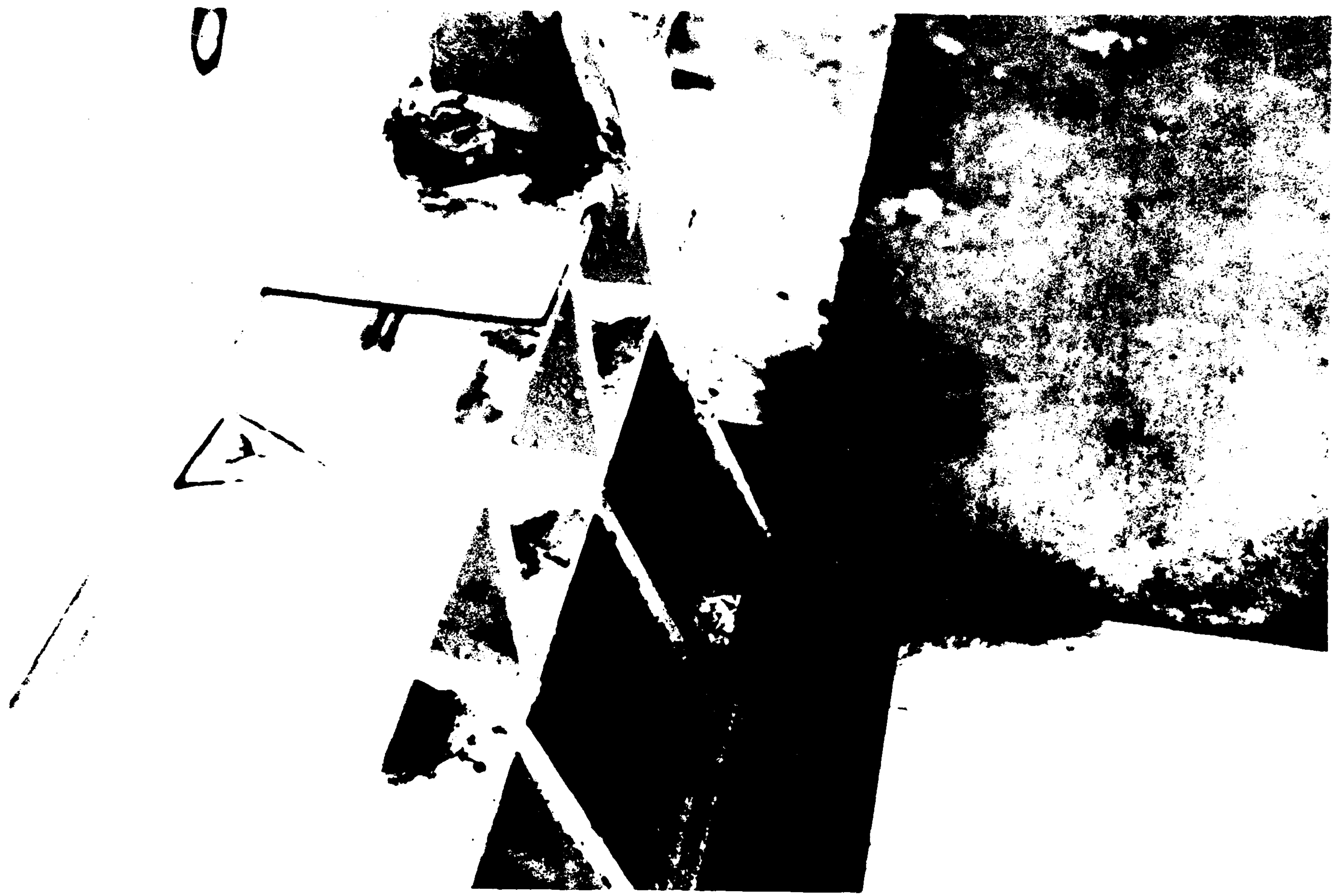

Figure 47 - Fender Structure Bolted Connection to Fender Foundation

Figure 48 - Fender Bolts Being Tightened to Reduce Movement

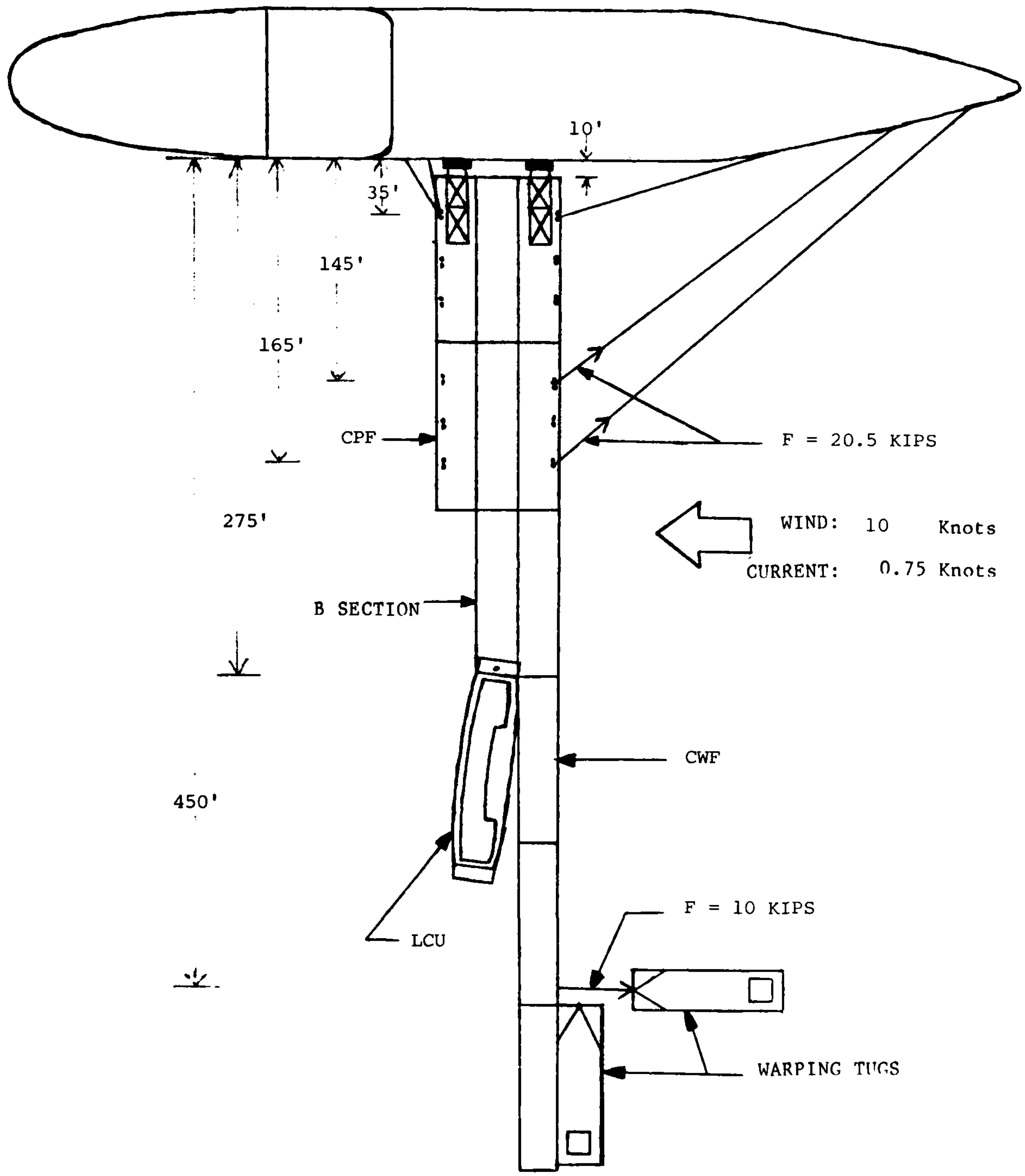

Figure 49 - Mooring Line Forces

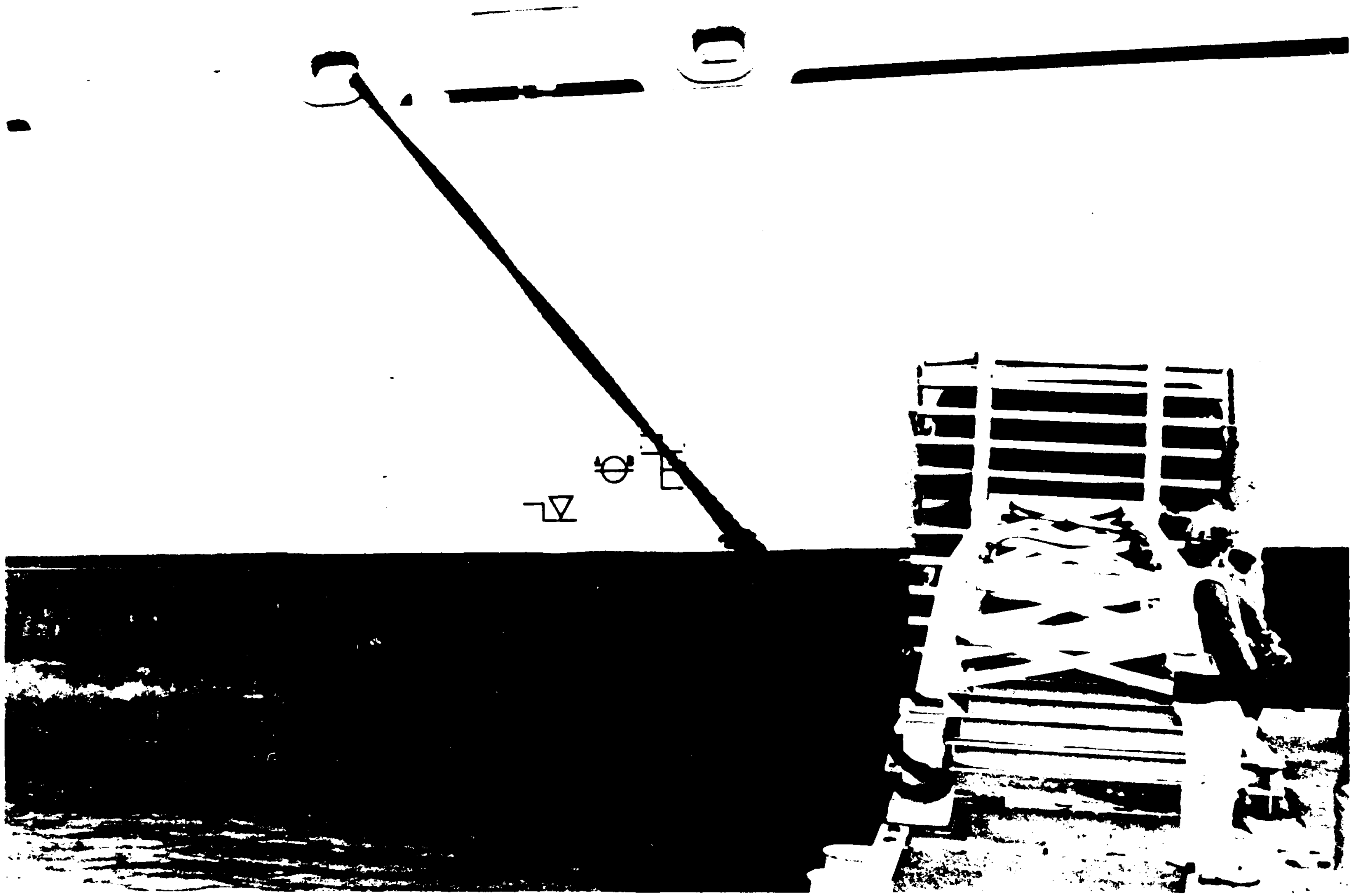

Figure 50 - Innermost Leeward Side Mooring Line (Double Wrapped on Bitt)

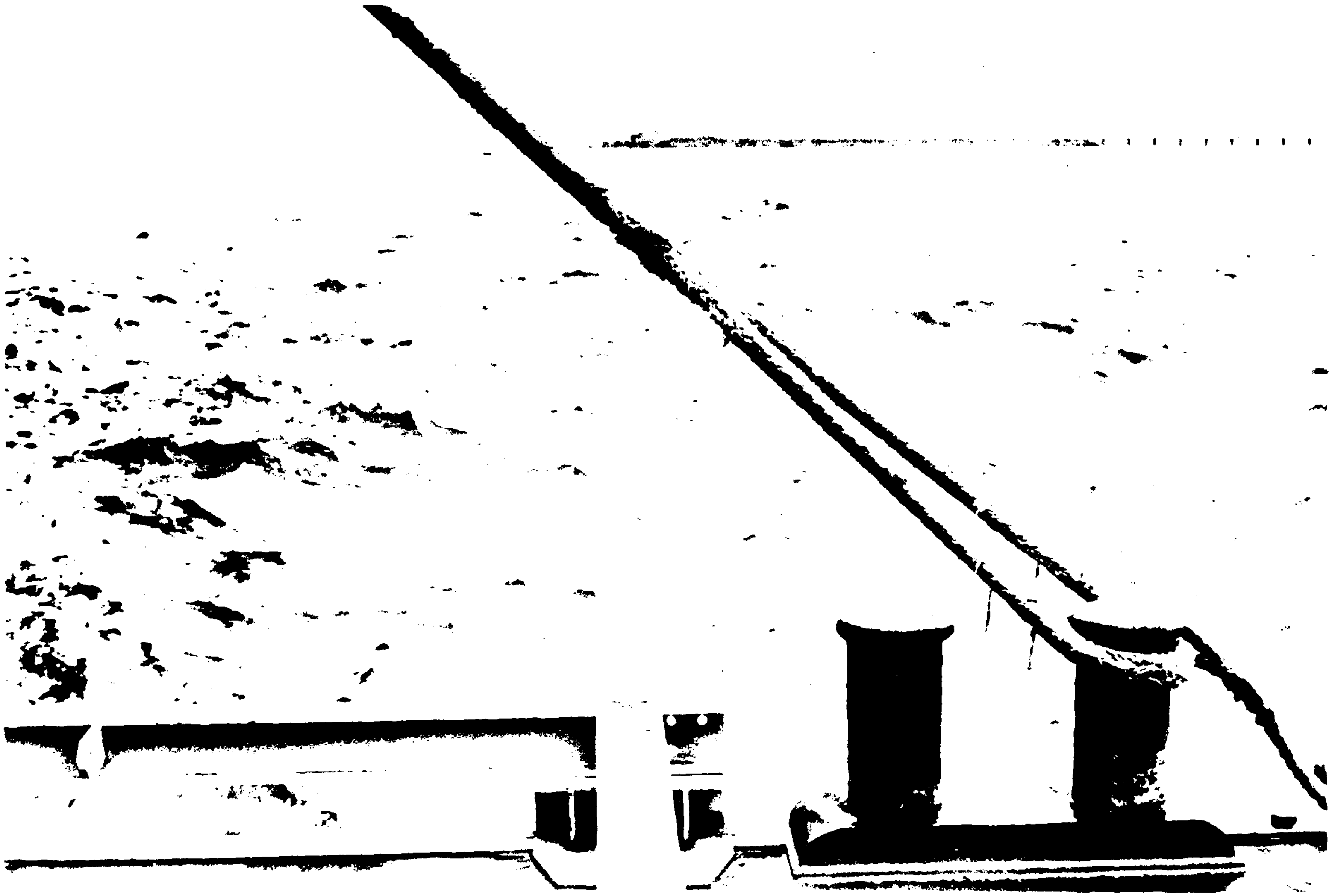

Figure 51 - Innermost Windward Side Mooring Line

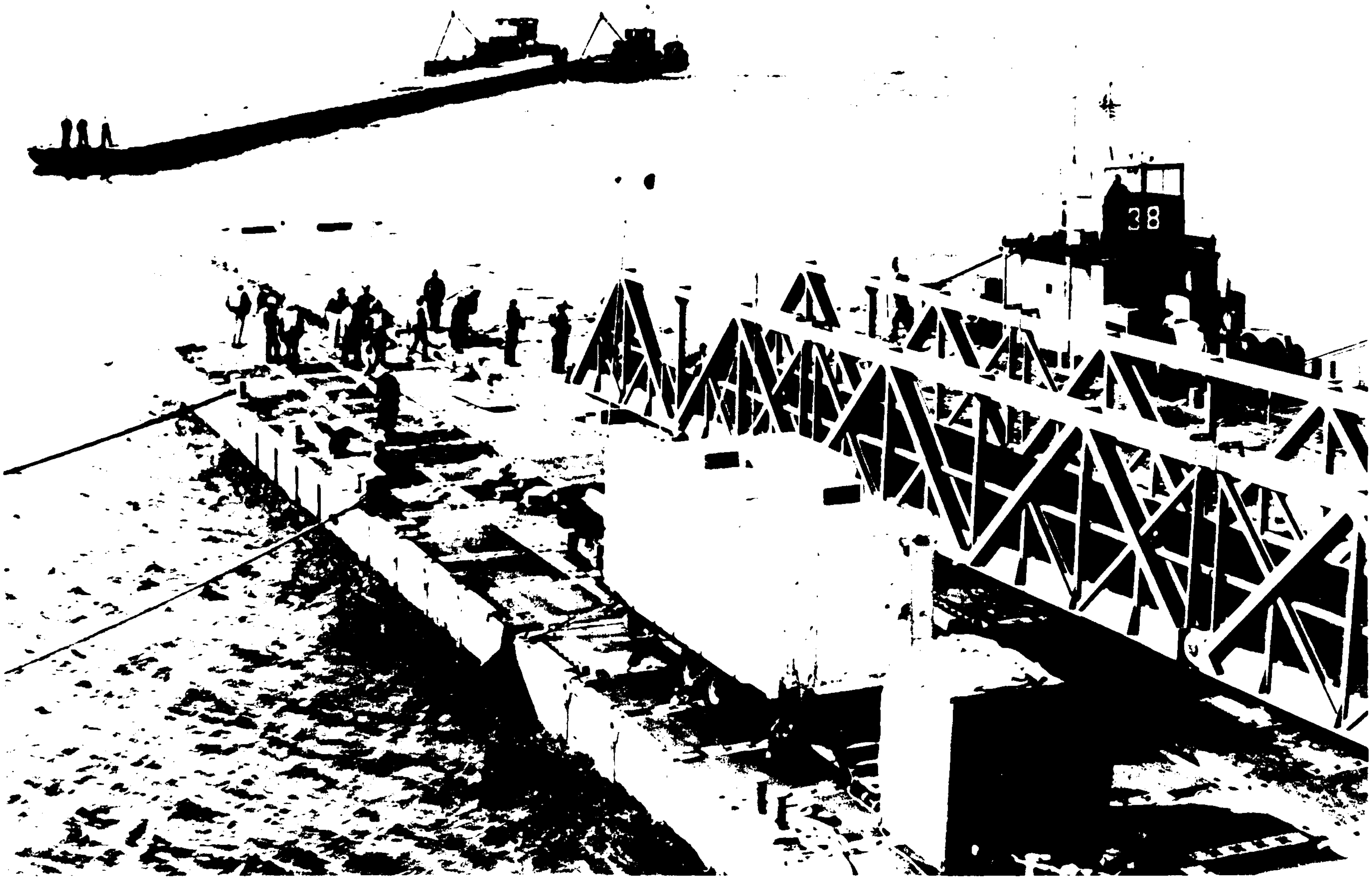

Figure 52 - Causeway Ferry Approaching CPF (Day 1)

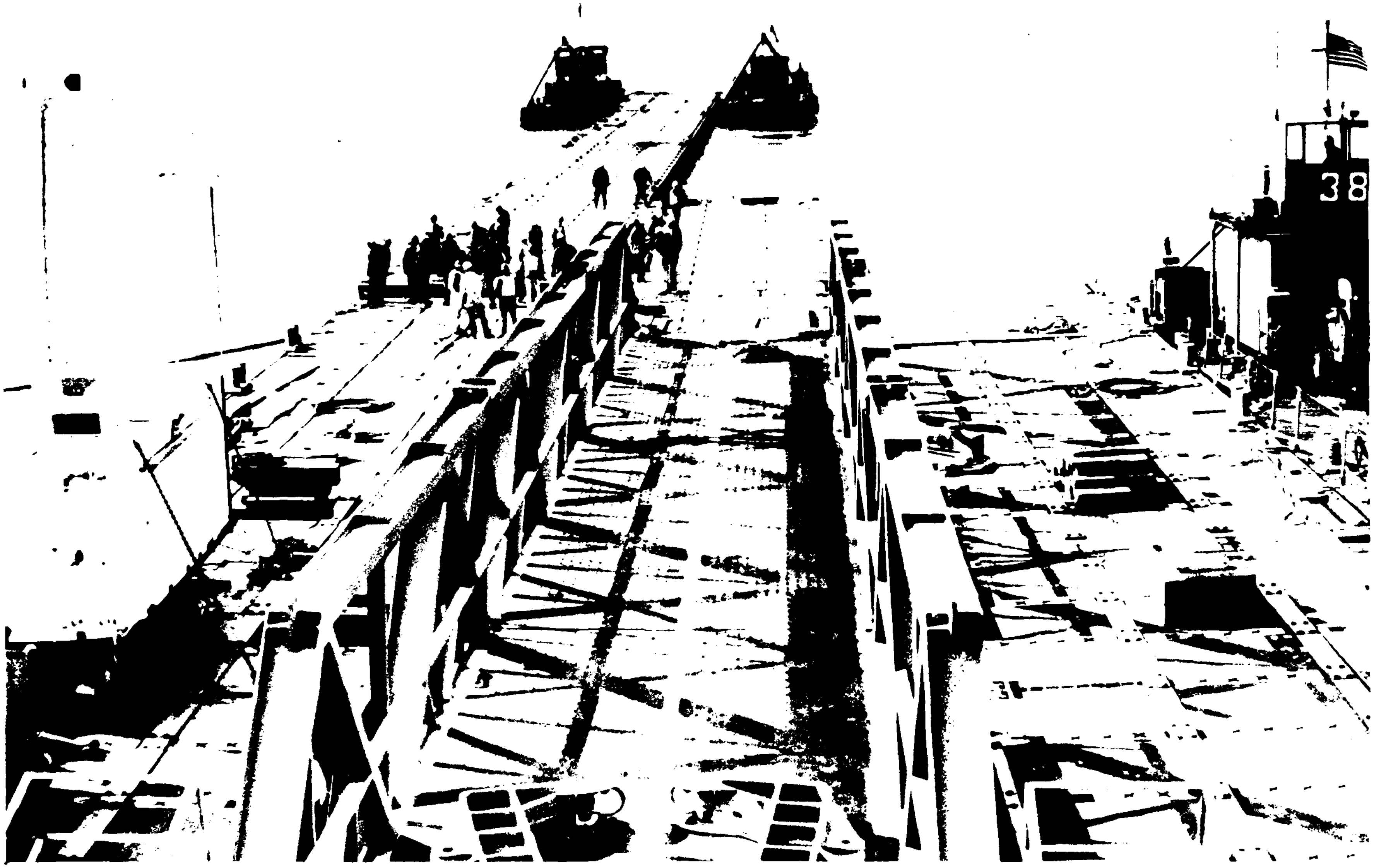

Figure 53 - Causeway Ferry Being Married to CPF (Day 1)

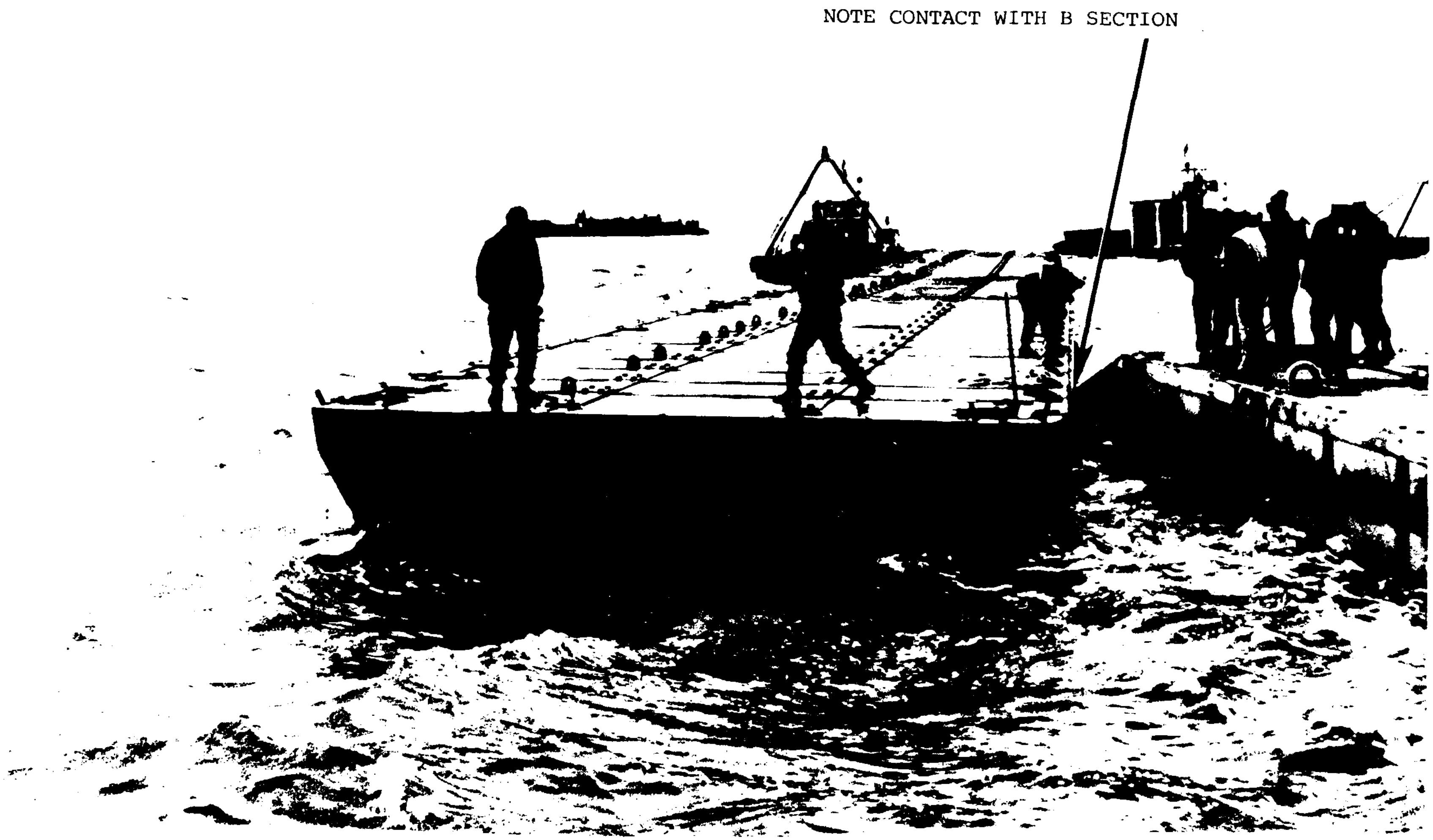

Figure 54 - Causeway Ferry Approach Windward Side of B Section (Day 2)

Figure 55 - Gouge in Causeway Ferry P-1 Can From Contact with B Section

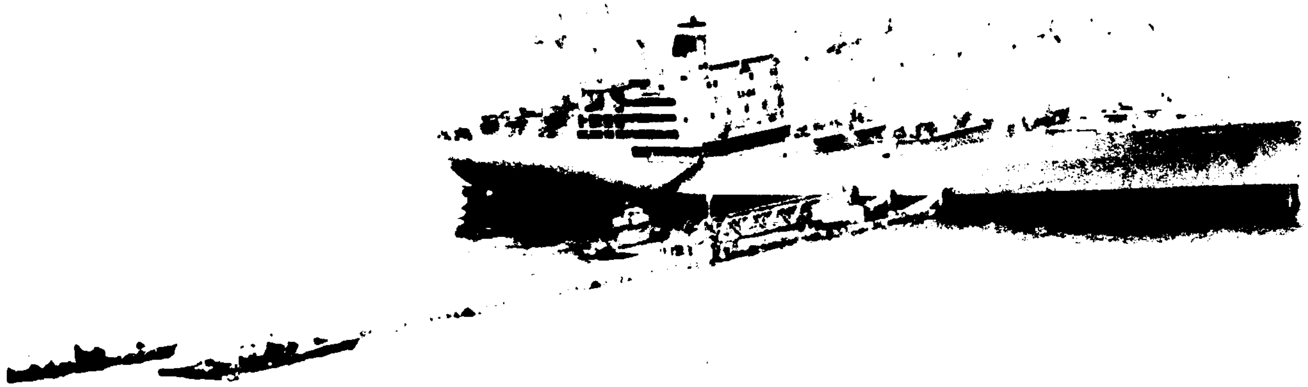

Figure 56 - Causeway Ferry Married to CPF (Day 2)

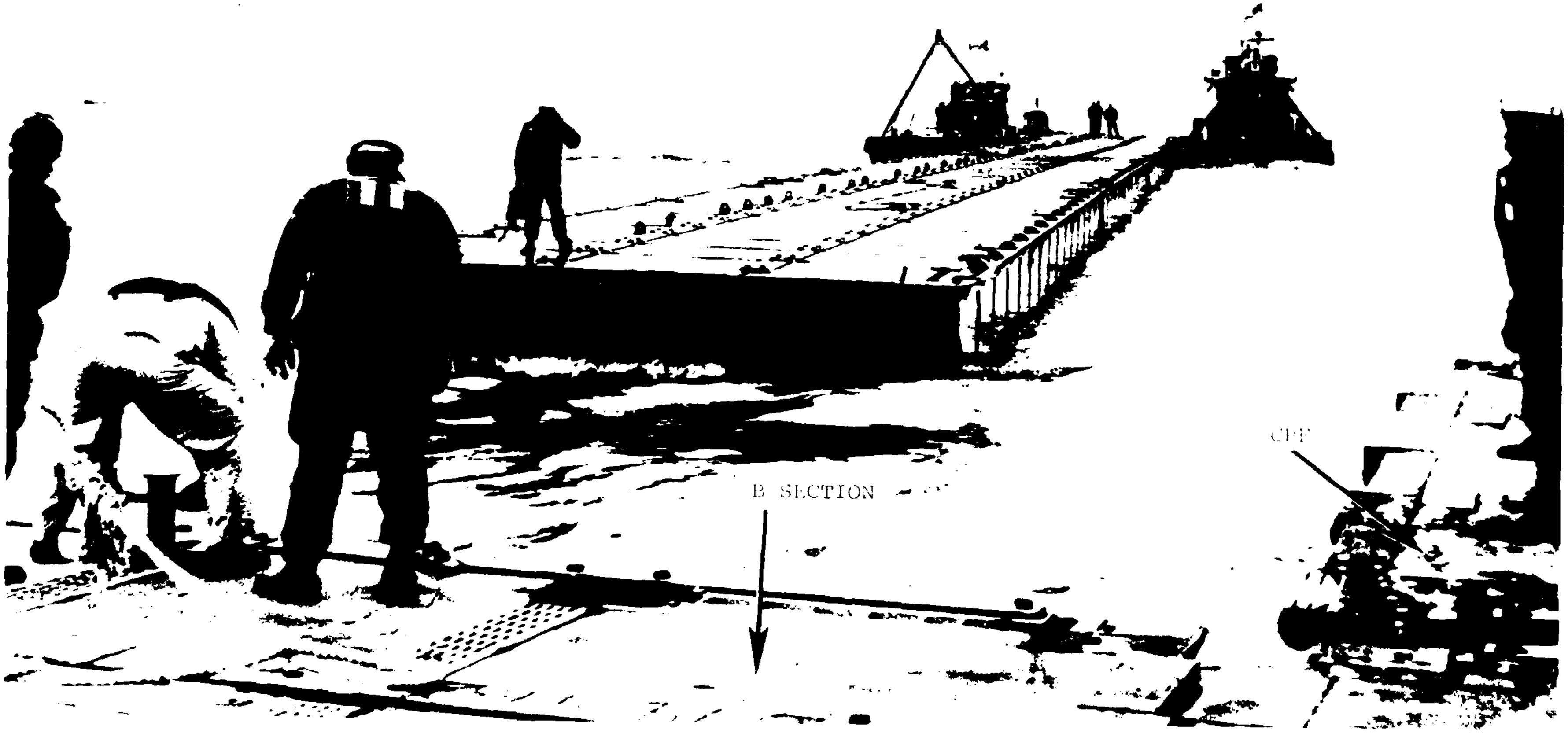

Figure 57 - Causeway Ferry Approaching at Right Angle to CPF

Figure 58 - Causeway Ferry Impacts Corner of CPF

Figure 59 - Results of Causeway Ferry Impact

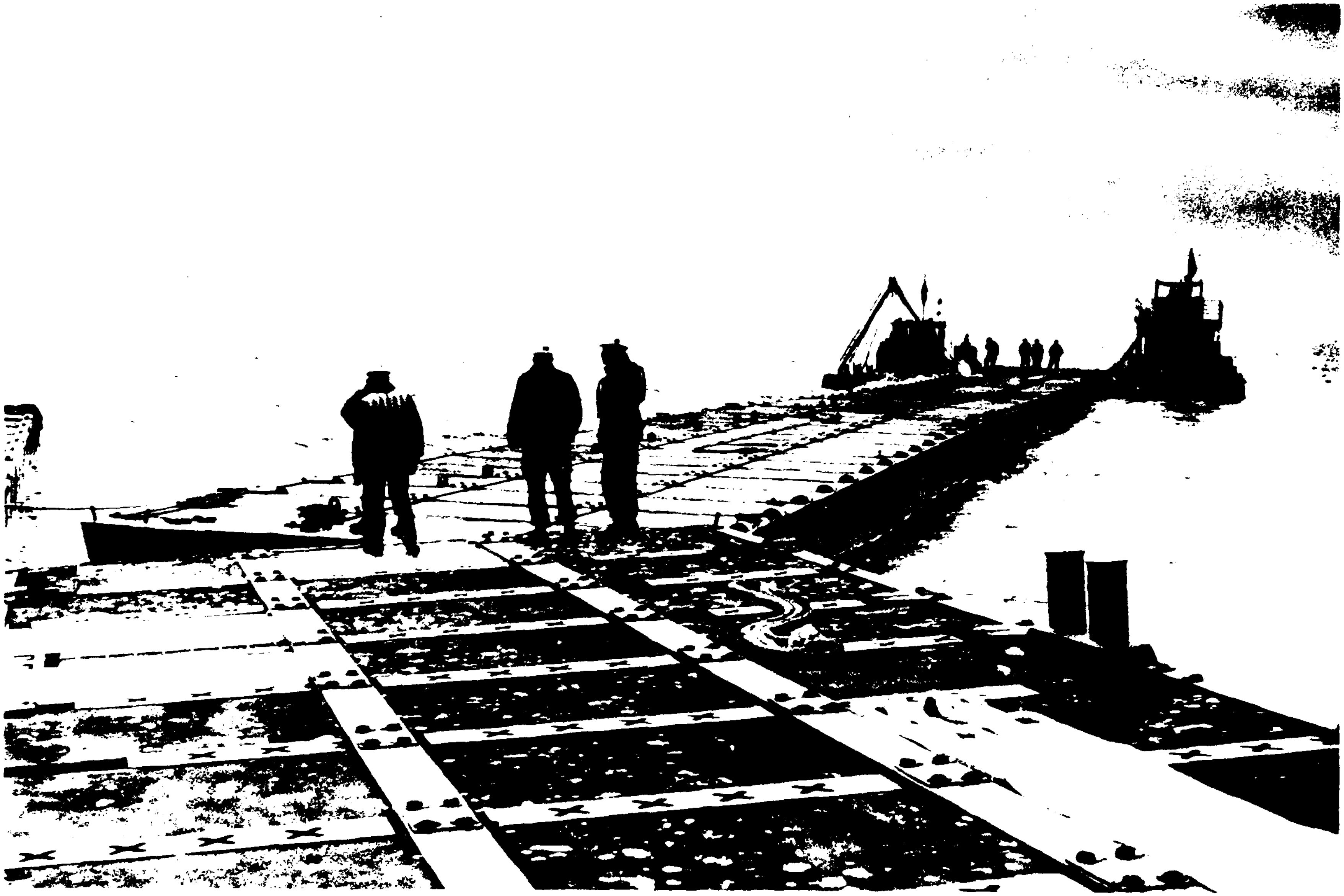

Figure 60 - Causeway Ferry Pivoting About Impact Area

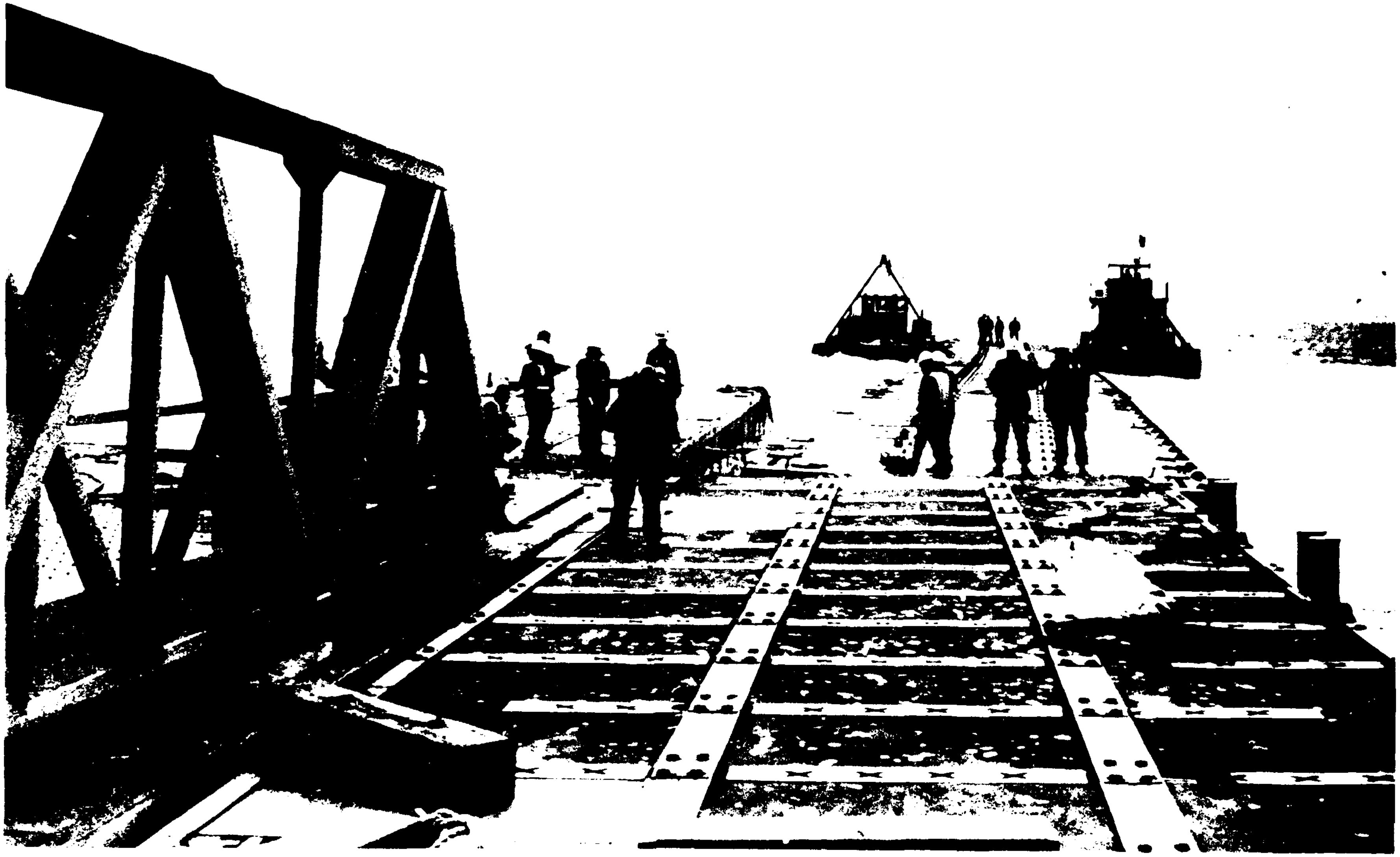

Figure 61 - Causeway Ferry Approaching Marriage Position

Figure 62 - LCU Marriage Alongside Married Causeway Ferry (Day 1)

Figure 63 - LCU Moored to B Section (Day 1)

Figure 64 - LCU Approach 1 (Day 2)

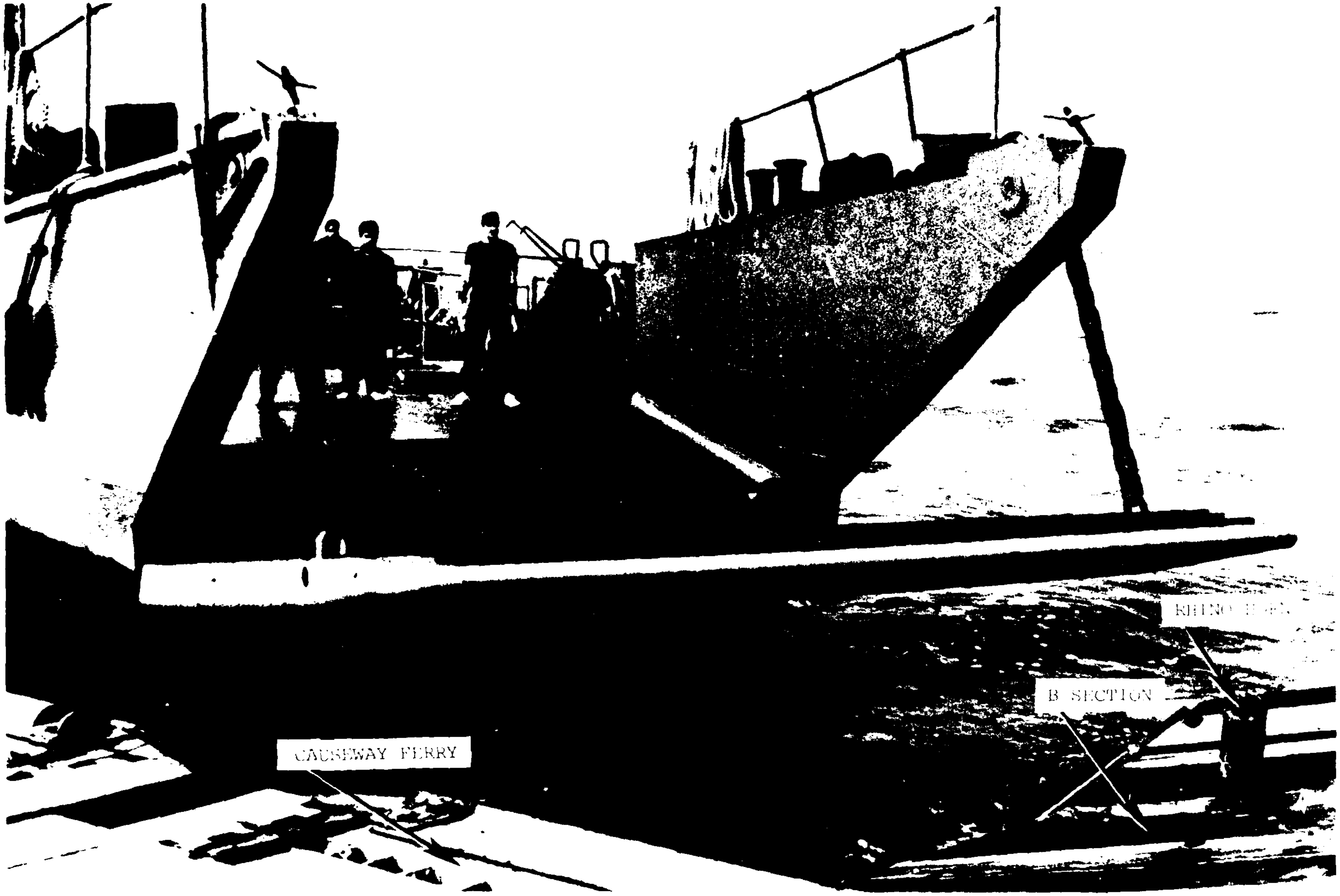

Figure 65 - LCU Approach 1 (Day 2)

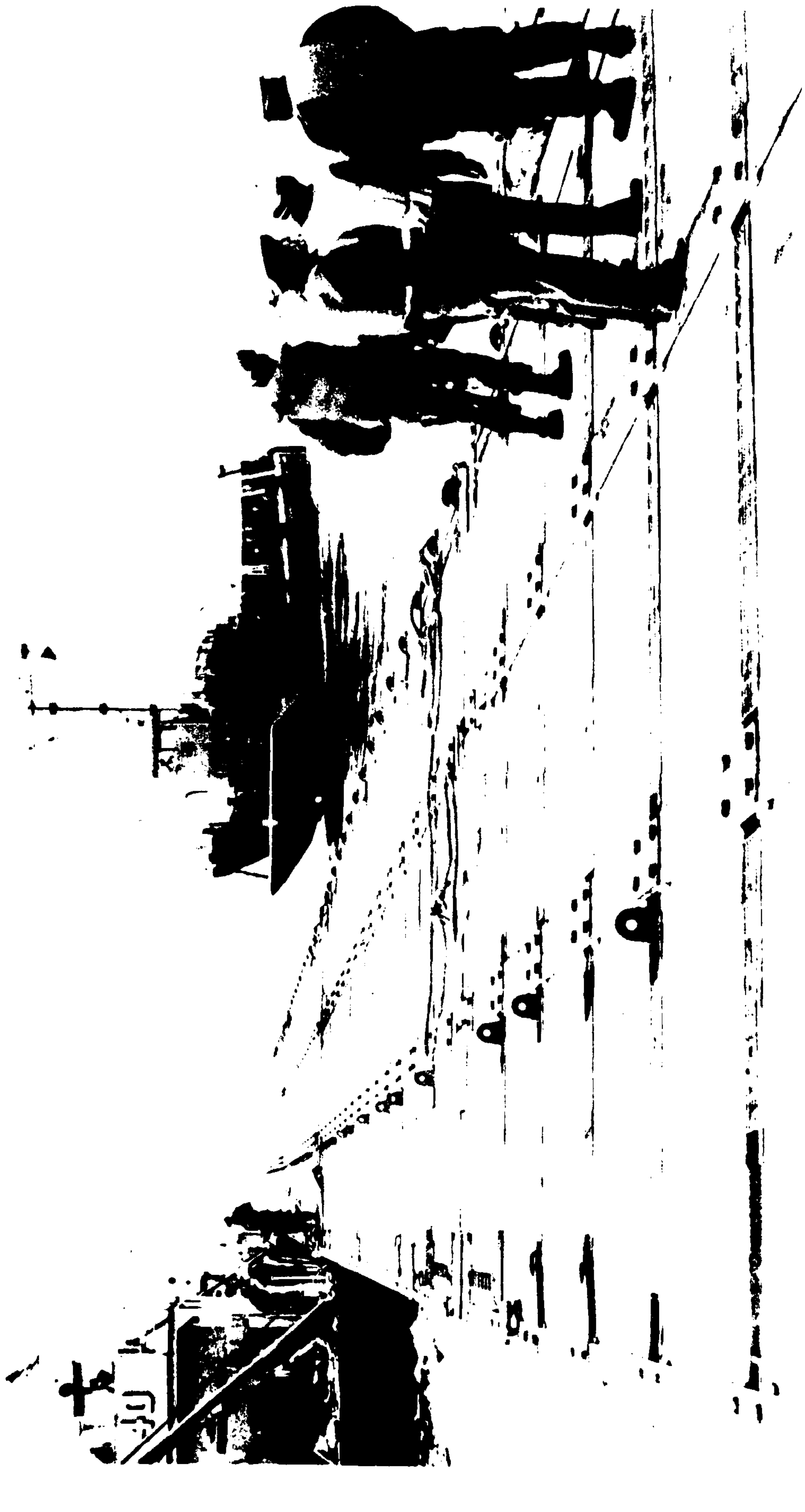

Figure 66 - LCU Approach 2 (Day 2)

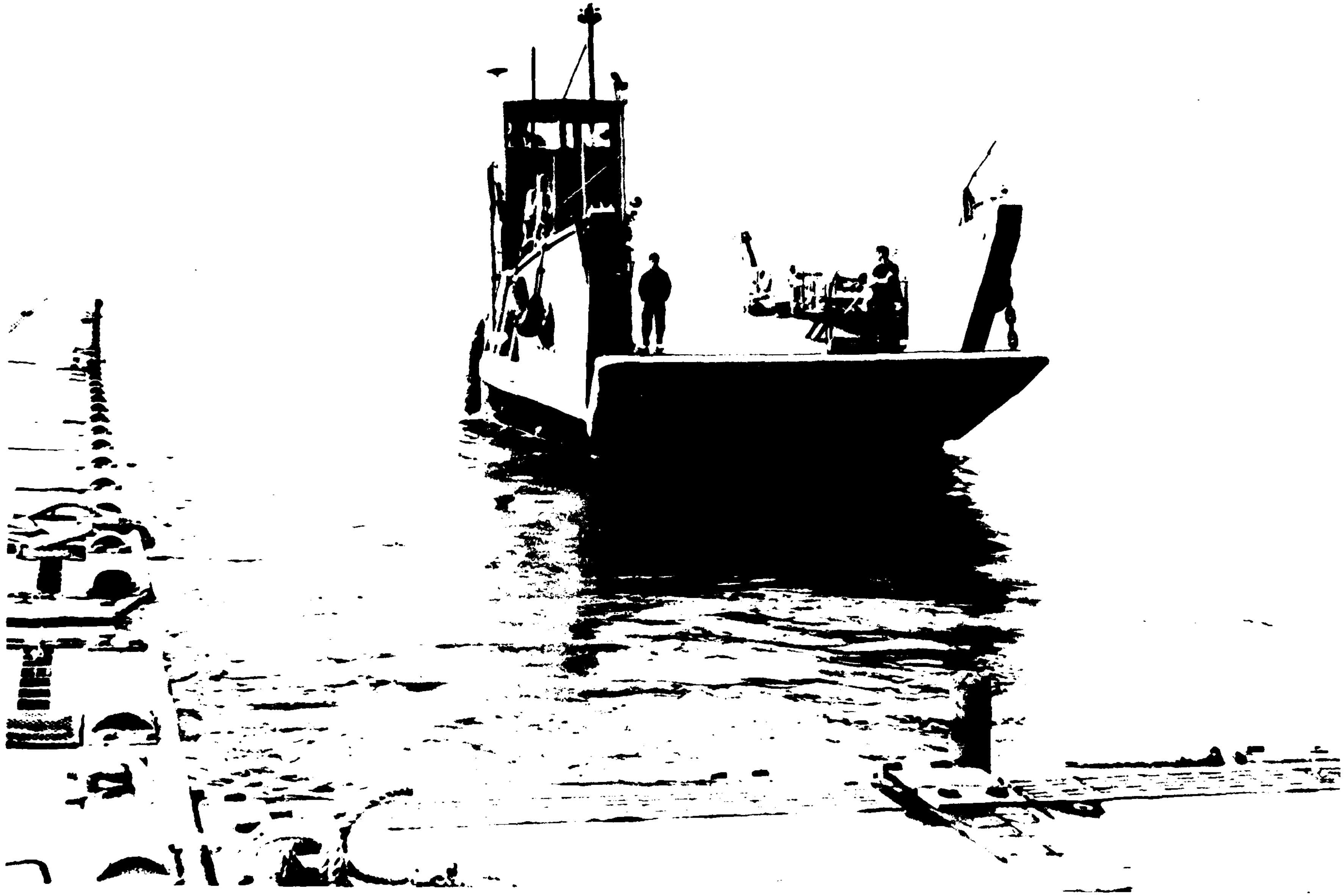

Figure 67 - LCU Approach 2 (Day 2)

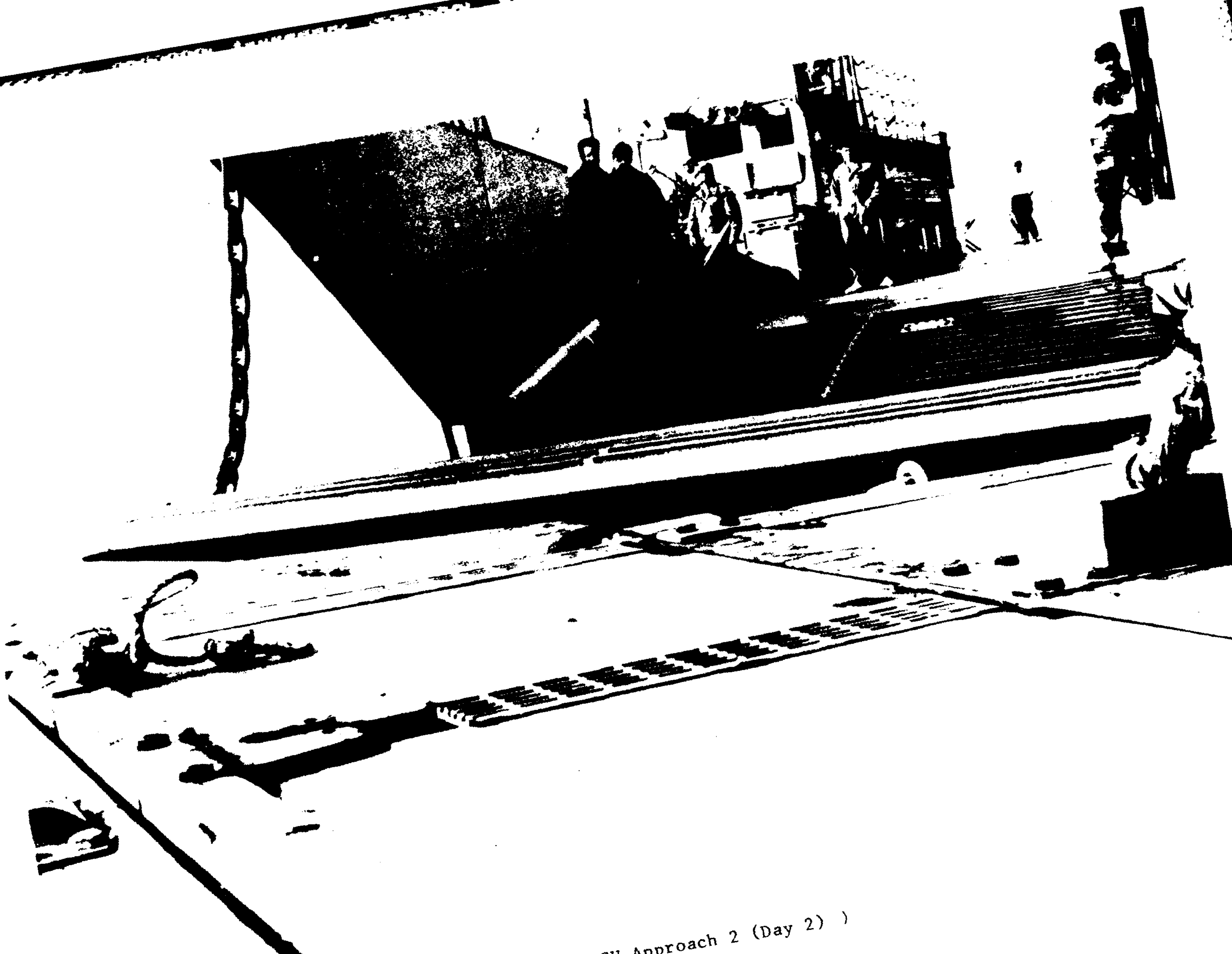

Figure 68 - LCU Approach 2 (Day 2))

Figure 69 - LCU Attempting Marriage with B Section (View 1) (Day 2)

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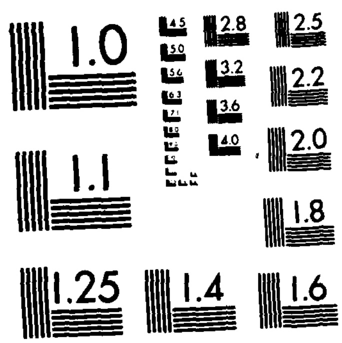

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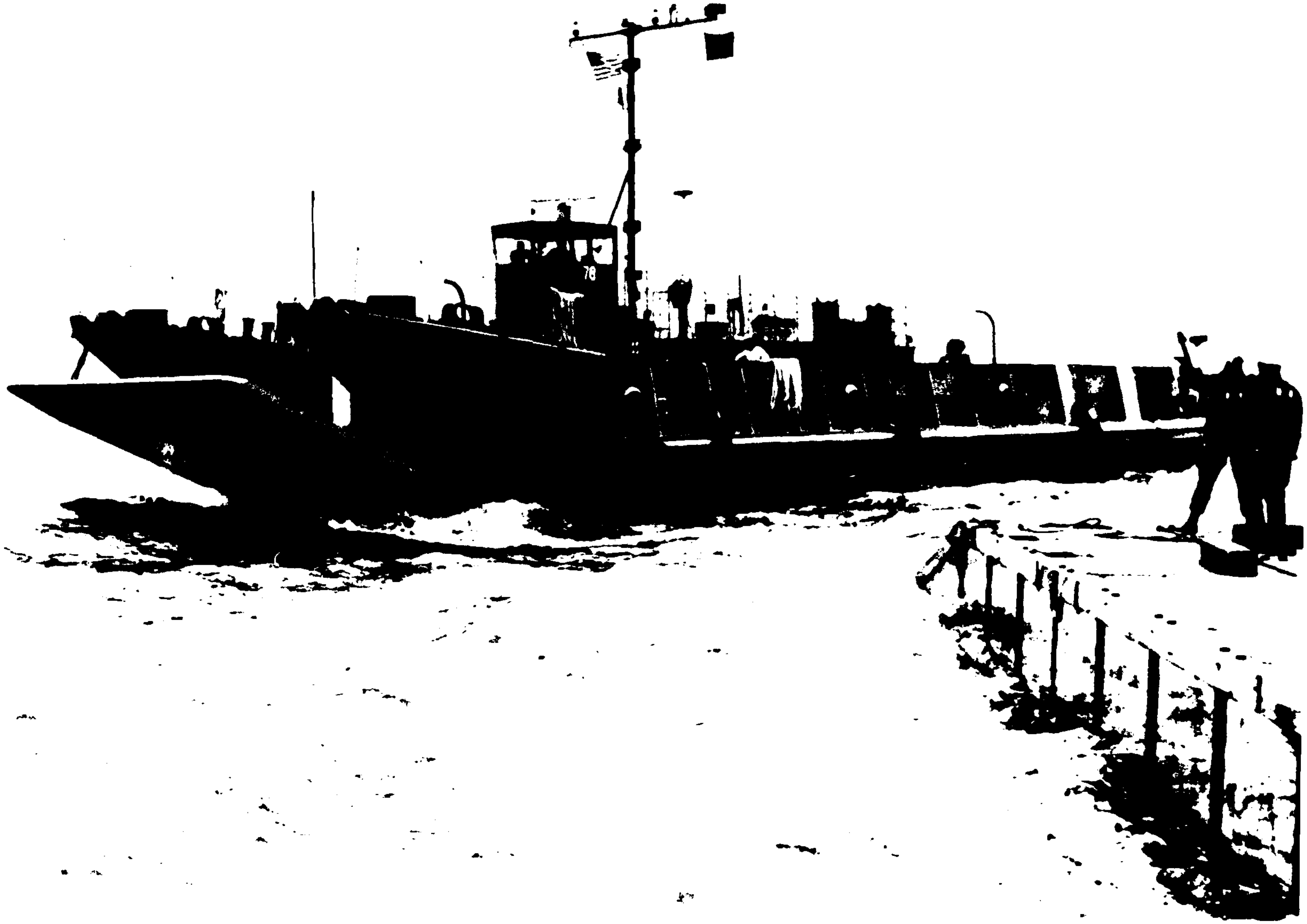

Figure 70 - LCU Attempting Marriage with B Section (View 2) (Day 2)

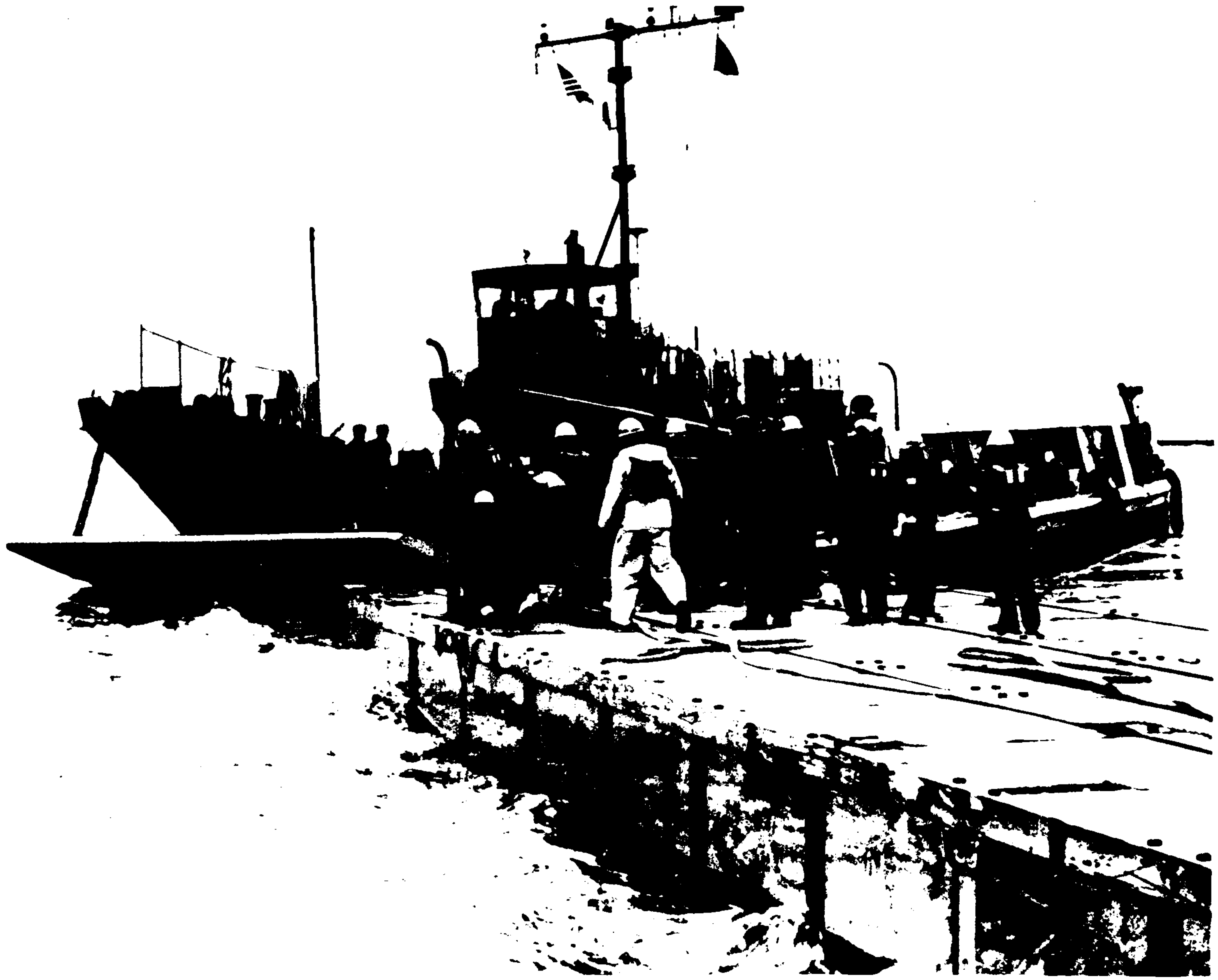

Figure 71 - LCU Attempting Marriage with B Section (View 3) (Day 2)

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